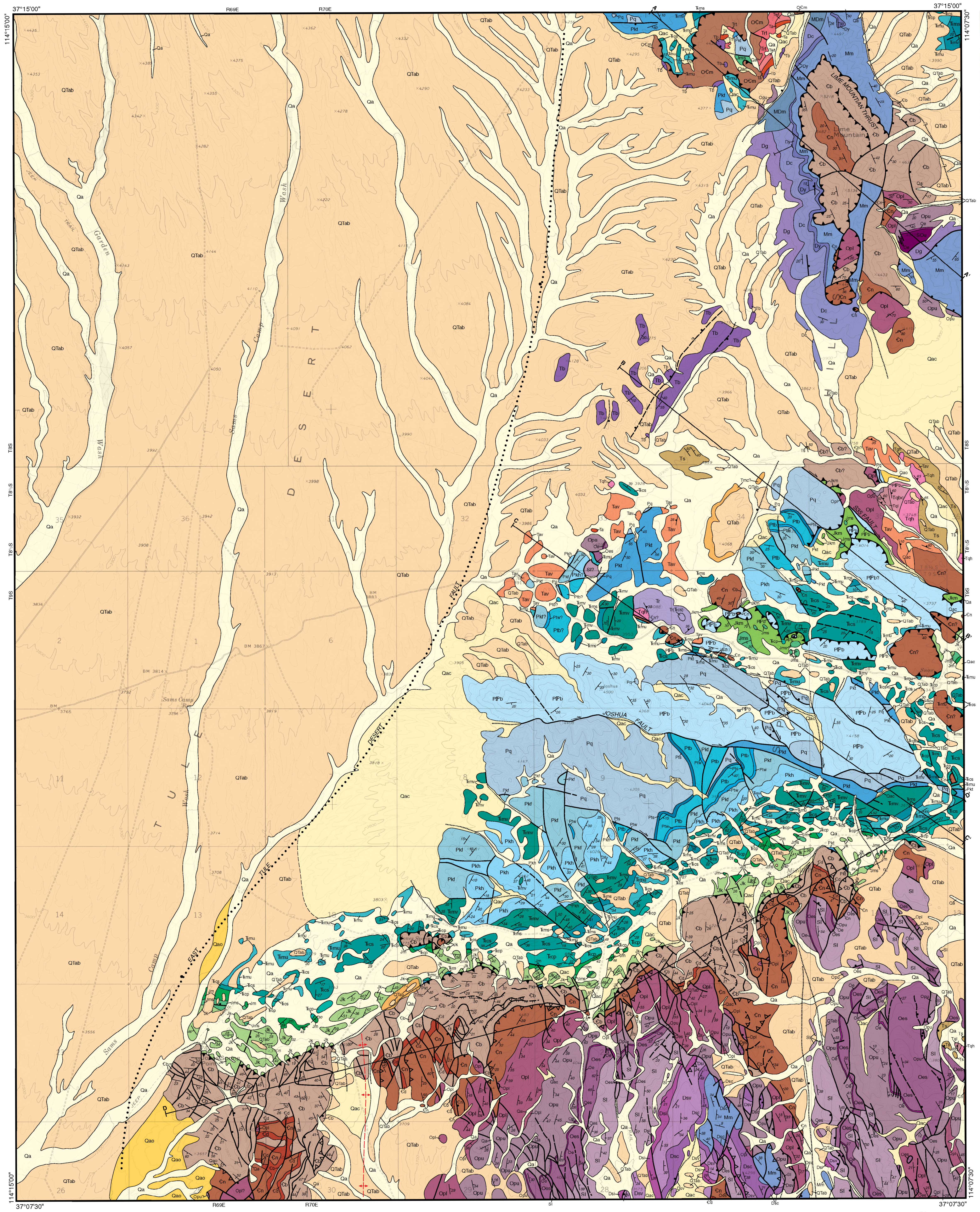
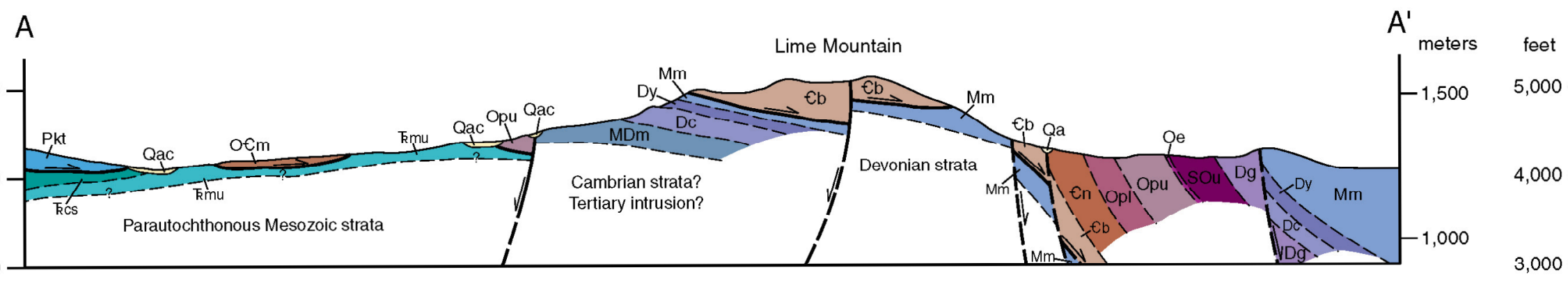
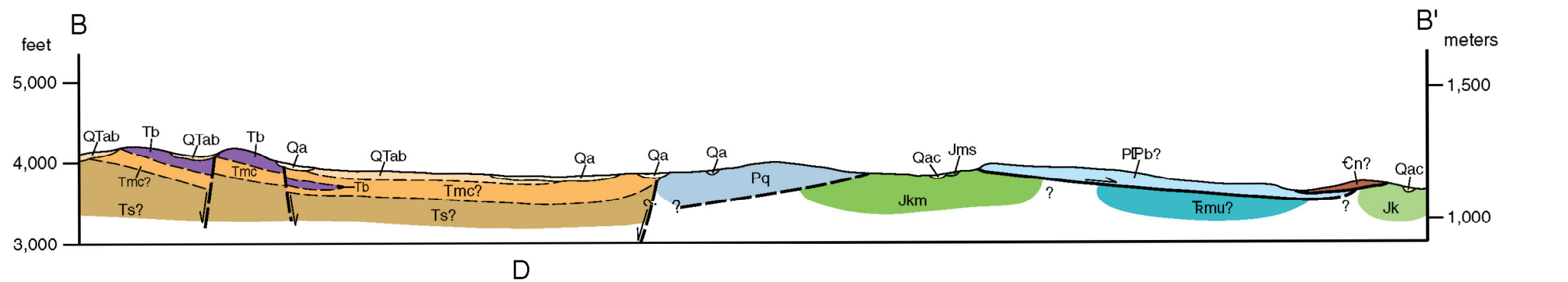
NEVADA BUREAU OF MINES AND GEOLOGY

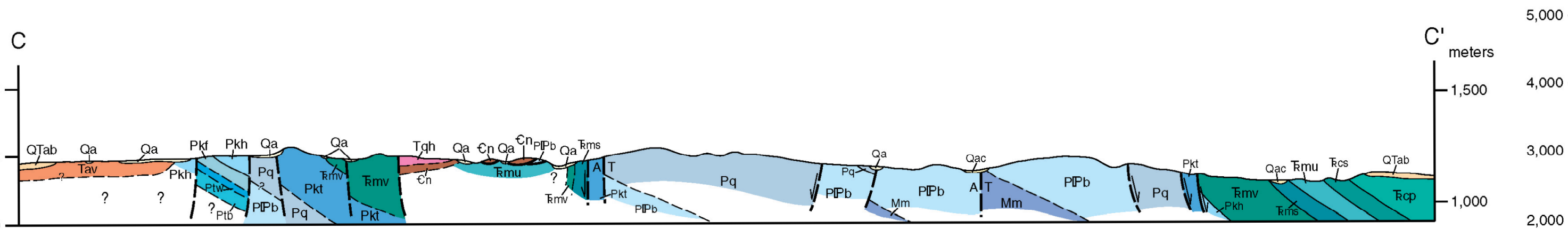
Prepared in cooperation with the Department of Geology, Brigham Young University, Provo, Utah

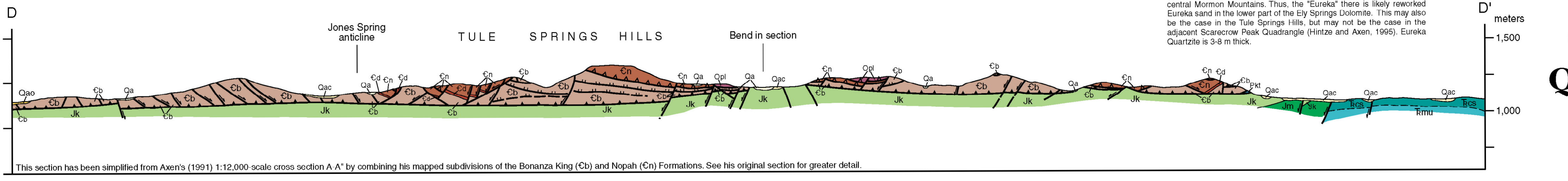
MAP 129 GEOLOGIC MAP OF THE LIME MOUNTAIN QUADRANGLE, LINCOLN COUNTY, NEVADA



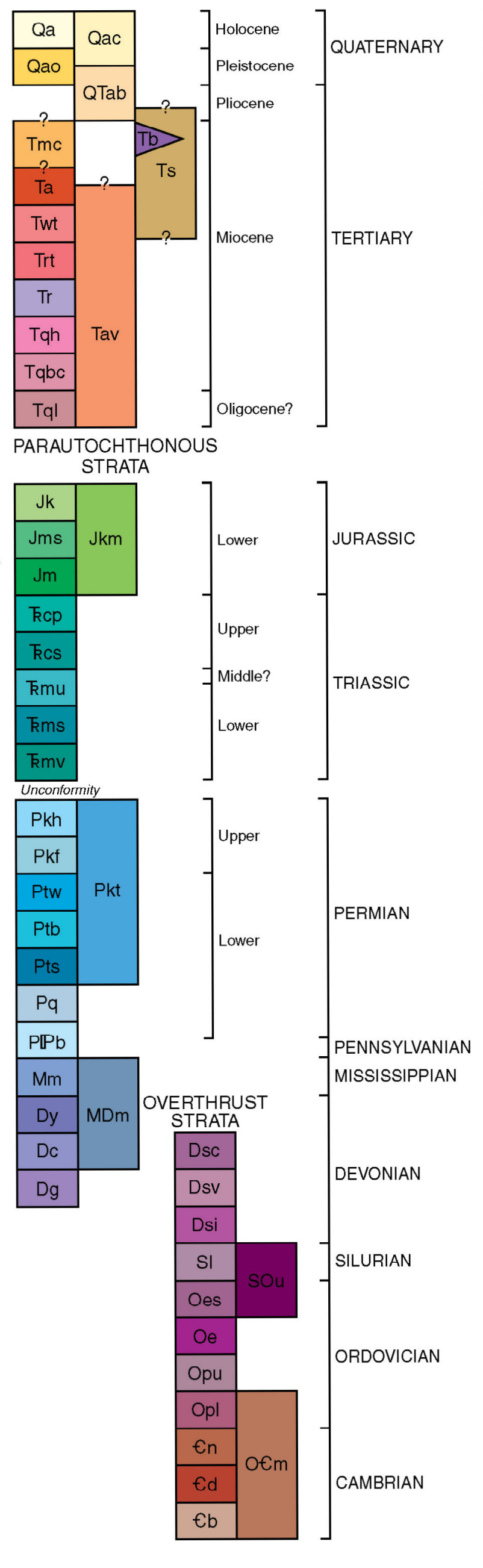








This section has been simplified from Axen's (1991) 1:12,000-scale cross section A-A'' by combining his mapped subdivisions of the Bonanza King (Ꞓb) and Nopah (Ꞓn) Formations. See his original section for greater detail.



Contact Dashed where approximately located.

Fault Dashed where approximately located, ball on downthrown side; arrow shows sense of strike-slip offset, queried where uncertain, dotted where concealed. In cross sections: A, movement away from viewer; T, movement toward viewer.

Concealed basin-and-range fault Indicated by geophysical data; ball on downthrown side.

Thrust fault that places older over younger strata Dashed where approximately located, sawteeth on upper plate.

Low angle fault that places younger over older strata Dashed where approximately located, sawteeth on upper plate.

Duplex fault Repeats imbricate slices of a unit, dashed where approximately located.

Gravity slide detachment

Strike and dip of bedding

25 Inclined   76 Overturned   ⊕ Horizontal

Strike and dip of foliation

30 Inclined

Anticline Showing plunge, dashed where approximately located.

Syncline axial trace (see figure 1)

Overturned syncline (see figure 1)

Measured stratigraphic section

Edge of thick Tertiary subsurface basin deposits (see figure 1)

See accompanying text for references and a discussion of the structural geology of the Lime Mountain Quadrangle.

Scale 1:24,000

0 0.5 1 kilometer

0 0.5 1 mile

0 1000 2000 3000 4000 5000 feet

CONTOUR INTERVAL 20 FEET

Base map: U.S. Geological Survey Lime Mountain 7.5' Quadrangle, 1973

Field work done in 1986-1998.

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Qa **Alluvium (Holocene)** Unconsolidated, poorly sorted stream deposits of gravel, sand, and silt in intermittently active stream and flood channels. Generally less than 20 m thick.

Qac **Alluvium and colluvium (Holocene and Pleistocene)** Unconsolidated, unsorted or poorly sorted alluvium and colluvium flanking bedrock outcrops. Mapped locally in areas where faults are concealed by unit Qac. In upland areas, thin patches of Qac were not mapped where bedrock continuity could be reasonably inferred beneath them. Thickness ranges from 0 to 30 m.

Qao **Older alluvium (Holocene? and Pleistocene)** Unconsolidated, poorly sorted stream deposits of gravel, sand, and silt that lie above present stream floodplain levels. Mapped in southwest part of the quadrangle. Thickness ranges from 0 to 30 m.

QTab **Alluvial basin-fill and piedmont-slope deposits (Pleistocene and Pliocene?)** Weakly to strongly consolidated deposits of subangular to subrounded silt, sand, gravel, and boulders. Mostly poorly exposed but appears to dip gently valleyward. Upper surface is commonly armored by a boulder-cobble colluvial residuum. In many places a well-developed caliche, a few meters thick, has formed a meter or so below the surface. Length of time necessary for development of such a thick caliche is estimated at between 1 and 2 million years (Machette, 1985). Thickness of unit ranges from zero on the flanks of buried hills of older rocks to perhaps more than 100 m.

Tb **Basalt (Miocene)** Grayish-brown to olive-gray, weathers dark-yellowish-brown to reddish-brown, mostly dense but locally vesicular, contains small phenocrysts of plagioclase and olivine in a glassy to finely crystalline matrix. Outcrops in the area near hill 4438 northwest of Lime Mountain contain coherent blocks tens of meters long but display no relict flow structures. They are probably products of in-place weathering; their outcrops are surrounded by unit QTab. Maximum thickness of unit Tb here is about 30 m. The larger outcrops 3 km southwest of Lime Mountain are probably faulted blocks of a single flow whose texture ranges from vesicular to dense and platy. Unit Tb here rests on poorly bedded, poorly sorted sand-pebble-cobble-boulder alluvium that is probably part of either unit Ts or unit Tmc with clasts about evenly divided between Paleozoic sedimentary rocks and Tertiary volcanic rocks. In the upper 20 m of this alluvium, just below the basalt, fragmented volcanic debris makes up 90% of the clasts and may represent a small landslide deposit. Tb is the only map unit in Tule Desert basin that is resistant enough to show normal fault offset within the valley fill. No isotopic age is available for this basalt. Maximum thickness of unit Tb in the south-central part of T8S,R70E is about 130 m.

Tmc? **Muddy Creek Formation (Miocene)** Light-pinkish- and orangish-gray, weakly consolidated siltstone and fine-grained sandstone. Generally low dips. Identification as Muddy Creek is tentative. Estimated thickness about 100 m where exposed; probably thicker beneath surficial cover in the Tule Desert basin.

Ts **Alluvial sediments with steep dips (Pliocene? or Miocene)** Weakly consolidated, poorly sorted alluvial sand, silt, and pebble conglomerate with a red silty matrix derived from the Kayenta Formation and angular and subangular clasts from various Paleozoic and Mesozoic sedimentary units and from various Tertiary volcanic units. Unit Ts is exposed principally in section 35, T8½S,R70E where it appears reddish-gray on color aerial photographs. Bedding attitudes can be seen only locally in stream cuts. This unit, and units Tb and Tmc? clearly underlie unit QTab which conceals their extent beneath the Tule Desert. Its dips, up to 50°, indicate that unit Ts occurs in tilted fault blocks that postdate early Miocene volcanism and may record late extensional deformation in the quadrangle. Maximum thickness of unit Ts is not known. Locally it is at least 100 m thick.

Tav **Altered volcanic rocks (Miocene)** Light-yellowish-gray to pinkish-gray slightly to highly altered tuff containing about 15% phenocrysts of quartz and sanidine and sparse mafic silicates in a devitrified pumice-poor matrix. Quartz is generally the only phenocryst seen in most exposures.

Hydrothermal alteration is widespread in the Miocene igneous rock in this quadrangle and the Tav designation has been applied to all outcrops where a more definite identification was not made. This is not meant to imply that those units listed below have not been altered, only that some patches of less altered rock have been left in good enough condition to permit field identification by geologists with experience in identifying these Nevada-Utah volcanic rocks, namely R.E. Anderson of the U.S. Geological Survey, Christopher Henry of the Nevada Bureau of Mines and Geology, and M.G. Best of Brigham Young University. These geologists have examined the areas shown as Tav on the maps and declared that the rocks were mostly too far gone to be more specifically identified. But there are locally small areas of unaltered rock patches that make specific identifications possible as shown on the maps. The present map probably includes the range of igneous rocks that are likely to be present.

Ta **Altered andesitic flow rocks (Miocene)** Grayish-brown andesitic rock streaked with reddish-brown iron staining. Alteration has destroyed most of the original crystals. Crops out only in a down-faulted block on northwest flank of Lime Mountain and is probably a small outlier of andesitic flows more widely exposed in the adjacent Dodge Spring quadrangle (Anderson and Hintze, 1993). Mark Anders of Lamont-Doherty Earth Observatory of Columbia University (personal commun., 2000) obtained an $^{39}Ar/^{40}Ar$ of 13.7±0.02 Ma on this unit on hill 4438 located one mile (1.6 km) northwest of Lime Mountain. Unit Ta is about 60 m thick.

Twt **White tuff (Miocene)** White, high-silica ash-flow tuff that contains large embayed and corroded quartz phenocrysts. Tuff is brecciated but not hydrothermally altered. R.E. Anderson examined unit Twt in October 1993 and suggested that it is probably correlative with either the Ox Valley Tuff or a rhyolitic tuff (unit Tra) that underlies the Ox Valley Tuff in the adjacent Dodge Spring Quadrangle (Anderson and Hintze, 1993) and may be correlative with the Kane Wash Formation of Cook (1965). Unit Twt is about 30 m thick.

Trt **Red tuff (Miocene)** Red-weathering tuff similar lithologically to unit Twt but stained with iron oxides. Slightly older than Twt but probably equivalent to part of the Ox Valley or Kane Wash Formations mentioned above, which are about 14 Ma. Mark Anders of Lamont-Doherty Earth Observatory (personal commun., 2000) obtained an $^{39}Ar/^{40}Ar$ age of 13.96±0.03 Ma on this unit on hill 4438 located one mile (1.6 km) northwest of Lime Mountain. Unit Trt is about 30 m thick.

Tr **Rhyolite lava flow and tuff(?) (Miocene)** This unit is mapped on hill 4088 in section 4, T9S,R70E where it is mostly light-yellowish-gray hydrothermally altered rock that locally retains patches of unaltered rock. Generally the rock is dense, mostly aphyric, locally moderately porphyritic with 25% phenocrysts of quartz and sanidine. Many outcrops show relict layering suggesting either flow or tuff bedding. The rock locally contains xenoliths of sandstone and conglomerate that may have been taken up from the Shinarump Member of the Chinle Formation. The largest xenolith is shown on the map. Age of the rhyolite has not been determined but it appears to overlie the Harmony Hills Tuff. Thickness is at least 50 m.

Quichapa Group (Miocene)

Tqh **Harmony Hills Tuff** Light-gray to pale-red, resistant to crumbly, moderately welded, crystal-rich, andesitic ash-flow tuff. Phenocrysts make up about one-third of rock; the most conspicuous are white plagioclase crystals as much as 4 mm long, and black biotite crystals as much as 2 mm across. Phenocryst percentages are, according to Rowley and others (1995): quartz, 5-10; plagioclase, 60; biotite, 20; hornblende, 7; clinopyroxene, 5; Fe-Ti oxides, 2; sanidine, 1±. Tuff includes red andesitic rock fragments as much as 5 cm long in its basal 10 m. A common weathering feature is the presence of crudely aligned, elongated vugs, as large as 1 cm by 4 cm. Layers containing flattened black glassy rock fragments also occur locally. The Harmony Hills Tuff in this quadrangle has suffered less hydrothermal alteration than the Bauers Tuff and Leach Canyon Formation. Perhaps its greater porosity has lessened its susceptibilty to alteration in some way. Rowley and others (1995) reviewed the isotopic dating of this tuff and concluded that it is 22.5-22 Ma in its type area, the Iron Springs mining district, 40 miles (64 km) to the northeast, in southwestern Utah. Maximum thickness in this quadrangle is about 80 m.

Tqbc **Bauers Tuff Member of the Condor Canyon Formation** Rocks assigned to the Bauers Tuff are in section 35, T8½S,R70E where they have been hydrothermally altered to light-yellowish-gray to purplish-brown, rust-stained fractured rocks that only locally retain vestiges of their original minerals and texture. The Bauers here is a low-silica ash-flow containing as much as 20% phenocrysts of which 25-50% are sanidine, 40-70% are plagioclase 2-10% are biotite, less than 3% are clinopyroxene, and 1-8% are Fe-Ti oxides. In section 35, the upper part of unit Tqbc has only a few percent of small relict phenocrysts. Locally, outlines of flattened pumice fragments can be found where the inclination of the layers can be measured. Thickness of the altered Bauers Tuff in section 35 is at least 60 m. Its age is 22.8 Ma (Rowley and others, 1995; Scott and others, 1995).

Tql **Leach Canyon Formation** An unaltered outcrop of this tuff is exposed in section 24, T9S,R70E where the rock is overturned in a small fault block. There it is a dark reddish-brown, moderately welded ash-flow tuff containing about 30% phenocrysts listed in order of decreasing abundance: plagioclase, quartz, sanidine, biotite, hornblende, clinopyroxene, Fe-Ti oxides, and accessory sphene, which mineral is critical to the identification of this tuff where it is unaltered. Dark-red lithic fragments are common in this tuff and also help to identify it. Leach Canyon Formation is also mapped in section 35, T8½S,R70E where it has been hydrothermally altered to a light-yellowish-gray, rust-stained rock that only locally retains vestiges of its original texture. The Leach Canyon Formation is at least (60 m) thick in section 35, T8½S,R70E, where it appears to rest uncomformably on lower Paleozoic strata. Its depositional age is 23.8 Ma (Rowley and others, 1995; Scott and others, 1995).

PARAUTOCHTHONOUS STRATA

Jk **Kayenta Formation (Jurassic)** Mostly dark-brownish-red silty sandstone, thin- to medium-bedded; basal 10 m is orangish-red siltstone that includes 2 m of interbedded white lacustrine dolomite beds that are visible on aerial photographs. Kayenta Formation is exposed from Jones Spring Point eastward for 9 km just beneath the overriding Paleozoic rocks of the Tule Springs Hills thrust; small outcrops of Kayenta at the same structural position are found along the east margin of the quadrangle north of Snow Spring. Maximum exposed thickness of Kayenta Formation here is about 60 m. In Beaver Dam Mountains 15 km to the east Hintze and others (1994) reported a total thickness of 550 m for the Kayenta.

Jkm **Tectonic melange of Kayenta and Moenave Formations (Jurassic deposition, Cretaceous tectonism and possibly Tertiary faulting)** Unit Jkm was mapped in section 3, T9S,R70E in an area where the Kayenta and Moenave Formations are so completely disrupted beneath allochthonous Paleozoic strata that their separate distribution cannot be shown at the scale of this map. Some coherent blocks of the distinctive Springdale Sandstone Member and the Petrified Forest Member are large enough to show on the map; they float in a tectonic mixture of lower Kayenta Formation, and Whitmore Point and Dinosaur Canyon Members of the Moenave Formation. Recognizable beds of each of these units are present within unit Jkm but can be traced for only a few meters where they terminate within the melange.

Moenave Formation (Jurassic)

Jms **Springdale Sandstone Member** Light-pinkish-gray medium-bedded, locally thin-bedded, fine-grained sandstone that forms low rounded ledges. Exposed intermittently from Jones Spring Point area eastward for 7 km but unit is commonly internally faulted. The Springdale Sandstone Member is at least 30 m thick.

Jm **Whitmore Point and Dinosaur Canyon Members undivided** The Dinosaur Canyon Member is a dark-brownish-red siltstone and sandstone that resembles the Kayenta Formation but is separated from it by the two distinctive upper members of the Moenave Formation. In this quadrangle the Dinosaur Canyon Member is at least 55 m thick. The recessive Whitmore Point Member is nowhere well exposed in this quadrangle. Fragments of its fossiliferous limestone beds are present within unit Jkm, and it may be represented directly east of this quadrangle by gray to white limestone and dolomite beds in the upper 10 to 20 m of Dinosaur Canyon Member (Hintze and Axen, 1995).

Chinle Formation (Upper Triassic)

Ŧcp **Petrified Forest Member** Varicolored purplish-gray or maroon bentonitic mudstone with interbeds of yellowish-, brownish-, and reddish-gray, coarse-grained, poorly sorted sandstone. Exposed discontinuously from section 24, T9S,R69E eastward for 10 km to Snow Spring. Maximum thickness in this quadrangle is about 100 m, but unit has probably been structurally attenuated. Member is fully exposed in the adjacent Dodge Spring Quadrangle where it is about 250 m thick (Anderson and Hintze, 1993).

Ŧcs **Shinarump Member** Grayish-orange to moderate-yellowish-brown, fine- to coarse-grained quartz sandstone. Basal few m is locally a conglomeratic sandstone with rounded quartzite and chert pebbles. Petrified wood fragments are locally common. Trough crossbedding common. Generally resistant, forming cuestas, hogbacks, or ledges. Maximum thickness about 75 m.

Moenkopi Formation

Ŧmu **Upper red member (Middle? and Lower Triassic)** Reddish-brown, thin-bedded, commonly ripple-marked mudstone, sandstone, and siltstone. Section measured along road in section 11, T9S,R70E showed the lower 30 m to be mostly recessive sandy siltstone, and the upper 50 m to be mostly resistant fine-grained sandstone.

Ŧms **Shnabkaib Member (Lower Triassic)** Light-gray to pinkish-gray, thin-bedded dolomite, siltstone, and gypsum that shows in light tones on aerial photographs. Section measured in section 11, T9S,R70E showed the lower 54 m to be mostly pinkish-gray to white, thin-bedded dolomite, and the upper 42 m to be 50 percent light-gray gypsum interbedded with light-gray and pinkish-gray, thin-bedded dolomite and siltstone. Total thickness is 96 m.

Ŧmv **Virgin Limestone Member (Lower Triassic)** Three-quarters interbedded light-gray, thin-bedded or laminated dolomite, and one-quarter greenish-gray, thin- to medium-bedded limestone. Forms slopes and angular ledges. Basal Virgin bed is 2 m of platy, ledge-forming limestone that contains 3-5% bedded chert, and a few pentagonal crinoid columnals. Top of Virgin Member placed at top of uppermost limestone bed. About 210 m thick as measured in section 11, T9S,R70E (Olmore, 1971). Olmore (1971) described 125 m of Virgin near Upper Lime Mountain Well 3 km north of the northeast corner of this quadrangle. He also recorded 450 m of Virgin east of Jumbled Mountain, about 8 km south of the southwest corner of this quadrangle, suggesting that the Virgin thickens southward across the quadrangle.

Kaibab Formation (Upper Permian)

Pkh **Harrisburg Member** Medium-gray to pinkish-gray limestone with 10-20% reddish-brown chert in blebs, nodules, and unevenly bedded irregular masses as much as 20 cm thick. Thick-bedded to massive; forms rounded ledges and cliffs. Thickness ranges from 50 to 200 m. There is a major Triassic-Permian erosional unconformity between the Harrisburg Member and the overlying Moenkopi strata.

Pkf **Fossil Mountain Member** Medium-gray fossiliferous limestone with 20-60% bedded dark-brown chert that gives its massive cliffs a nearly black aspect. Some of its spherical chert nodules are crudely silicified fossil sponges. Thickness ranges from 50 to 65 m.

Toroweap Formation (Lower Permian)

Ptw **Woods Ranch Member** Nonresistant silty sandstone with interbeds of gypsum. Not well exposed in this quadrangle; forms slopes and saddles between the adjacent resistant map units. About 20 m thick.

Ptb **Brady Canyon Member** Light-gray limestone and dolomitic limestone with 10-30% bedded chert. Contains sparse brachiopod, coral, and crinoid fragments. Forms rounded cliffs and ledges. Thickness about 70 m.

Pts **Seligman Member** Light-brown to white calcareous sandstone interbedded with thin beds of shale and limestone in its upper half. Well exposed in NW 1/4 of section 10, T9S,R70E where it is 40 m thick.

Pkt **Tectonic melange of Kaibab and Toroweap Formations (Permian deposition, Cretaceous tectonism and possibly Tertiary faulting)** This map unit designates an area on the north edge of the quadrangle and in section 33, T81/2S,R70E, and section 4, T9S,R70E where tectonism has so disrupted Permian strata that the carbonate units could not be recognized separately. Thickness of melange probably less than 200 m.

Pq **Queantoweap Sandstone (Lower Permian)** Reddish- to orangish-brown-weathering, fine-grained quartzite. Small-scale crossbedding common. Forms blocky scree slopes that lack prominent ledges. Thickness not measured in this quadrangle because no unfaulted section was found. Welsh (1959) measured 905 m of Queantoweap in the southern Mormon Mountains 30 miles (48 km) to the southwest. Hintze and Axen (1995) reported 500 m thickness in the adjacent Scarecrow Peak Quadrangle.

PIPb **Bird Spring Formation (Lower Permian and Pennsylvanian)** Cyclic medium-gray limestone in lower two-thirds, medium to light-gray dolomite in upper one-third; contains 2-10% chert, mostly as irregular bedded masses, but in spherical or egg-shaped masses in some beds; thick-bedded to massive, form ledges and low cliffs 1-4 m high; unfossiliferous except for a few meters of beds below the upper dolomite where bioclastic limestone contains sparse silicified productid brachiopods. No complete section of Bird Spring Formation is exposed in this quadrangle; however, in section 4, T9S,R70E, on the northwest nose of "Joshua" hill, an unbroken partial section of about 300 m of Bird Spring Formation is well exposed. Welsh (1959) measured 670 m of Bird Spring in the southern Mormon Mountains about 30 miles (45 km) to the southwest of Lime Mountain. Regional thickness of the formation may be about 600 m (Hintze and Axen, 1995).

Mm **Monte Cristo Limestone (Mississippian)** Massive, light-gray limestone; some beds bioclastic with small crinodal fragments; contains sparse corals, gastropods, and brachiopods. Unit Mm is locally bleached by thermal metamorphism on the north end of Lime Mountain caused by small intrusions in the south part of the adjacent Jacks Mountain Quadrangle. The most complete, least deformed, unaltered section is located on the southeast flank of hill 4365 about 2 km southeast of the crest of Lime Mountain. Thickness is about 300 m.

MDm **Marble (Mississippian and Devonian deposition, Tertiary igneous baking)** Gray to white recrystallized carbonate rocks of the Monte Cristo and Crystal Pass Limestones on the northwest flank of Lime Mountain.

Crystal Pass Limestone (Upper Devonian)

Dy **Yellow shaly member** Medium-light-gray, finely crystalline, thin- to thick-bedded limestone with a 5 m olive-green shale bed 22 m above the base. Unit Dy weathers to form a yellowish-gray bench above the quartzite at the top of unit Dc. Biller (1976) described unit Dy as units 11-15 in his measured section. Biller's measured section continued up through his unit 24, but his unit 16 and above we believe to be Mississippian Monte Cristo Limestone. Devonian brachiopods and conodonts are abundant in the upper half of unit Dy. Biller's (1976) thickness for this unit (his measured section units 11-15) is 44.5 m.

Dc **Cliffy limestone member** The top 2 m of this unit is a pinkish-gray, medium-grained quartzite that Biller (1976) called the "Cove Fort Quartzite," using a term from central Utah; this quartzite is too thin to show as a separate map unit, but it serves as an easily identifiable top for unit Dc. Biller (1976) called the predominantly medium-light-gray, ledge- and cliff-forming limestone beneath the upper quartzite "Guilmette Formation" (his measured section units 1-9), but we place these light-gray rocks in the Crystal Pass Limestone and use Guilmette Formation for the dark-gray dolomite at the bottom of the exposed Devonian section. Unit Dc includes several thin beds of quartzite interbedded with the limestone which locally contains fossil fragments and Devonian conodonts. Biller (1976) described a thickness of 83 m of unit Dc strata.

Dg **Guilmette Formation (Upper Devonian)** Dark-gray, medium- to thick-bedded, medium- to coarse-grained dolomite that forms ragged ledges and cliffs on the flanks of Lime Mountain. Contains reycrystallized stromatoporoids of "spaghetti" and "cauliflower" shapes. Base not exposed. Thickness about 70 m. Equivalent to Ironside Dolomite Member of the Sultan Limestone as mapped by Axen in the Tule Springs Hills in the southern part of the quadrangle.

OVERTHRUST STRATA

Mm **Monte Cristo Limestone (Mississippian)** Monte Cristo Limestone is exposed in the Tule Springs Hills on the south edge of the map where it is the youngest Paleozoic rock there on the overthrust plate. It is similar in appearance to the Mississippian strata on Lime Mountain. Estimated thickness is about 150 m.

Sultan Limestone (Upper Devonian) In mapping the Tule Springs Hills that reach into the southern edge of this quadrangle, Axen (1991) used subdivisions of the Sultan Limestone that were established in the Goodsprings Quadrangle southwest of Las Vegas by Hewett (1931). We have retained Axen's mapping units, as listed below, for the southern part of our map, but have used different subdivisions near Lime Mountain, as described above, to better portray the difference in Devonian strata between the north and south parts of this map. A well-exposed, unbroken section of Sultan Limestone is located in SW1/4, section 22, T9S,R70E.

Dsc **Crystal Pass Limestone Member** Light- to medium-gray weathering, aphanitic to fine-grained, laminated to thin-bedded limestone and dolomitic limestone that locally contains the large brachiopod *Cyrtospirifier*. Includes one or two 1-3 m thick quartz sandstone beds in its upper third. Nothing comparable to unit Dy, described above, is found in the Tule Springs Hills. Estimated thickness is 70 m.

Dsv **Valentine Dolomite Member** Medium- to light-gray, fine- to coarse-grained, unfossiliferous dolomite that includes a 2 m bed of brown-weathering dolomitic sandstone in the middle. Estimated thickness is 110 m.

Dsi **Ironside Dolomite Member** Medium- to dark-gray to brownish-black, fine- to coarse-grained, thin- to medium-bedded dolomite. Locally contains recrystallized stromatoporoids of "spaghetti" (*Amphipora*) and "cauliflower" shapes. Estimated thickness 50 m.

Sl **Laketown Dolomite (Silurian)** Mostly light-gray, thick-bedded dolomite with interbeds of pinkish- and yellowish-gray, thin-bedded, silty dolomite in upper half. A well-exposed, unbroken sequence of unit Sl is exposed in SE1/4, section 21, T9S,R70E. A conodont sample from an elevation 3820 feet on the west side of hill 3910 there was identified by W. Britt Leatham (memorandum report, 2 February 1996) as containing conodont elements typical of Lower Laketown faunas in Utah and Nevada. The color alteration index, CAI 2, for the sample indicates a history of relatively low temperatures even though Leatham reported finding fine flakes of detrital biotite/phlogopite in the heavy residue. Estimated thickness is 160 m.

SOu **Laketown and Ely Springs Dolomites, undivided (Siluran and Upper Ordovician)**

Oes **Ely Springs Dolomite (Upper Ordovician)** Medium-gray, fine- to medium-grained, thin- to thick-bedded dolomite that locally contains some bedded nodular chert. The least-deformed exposures are in section 21, T9S,R70E. Estimated thickness is about 100 m.

Oe **Eureka Quartzite (Middle Ordovician)** Fine- to medium-grained, gray quartzite that weathers dark-brownish-gray; cross-bedded in 15- to 30-cm-thick layers; probably formed in a shallow marginal marine environment. Forms resistant ledge visible on aerial photographs. Contact with overlying dolomite is gradational; sandy cross-bedded dolomite is interlayered with quartz sandstone. In most areas unit Oe is too thin to show on a map of this scale; its map width has been exaggerated because, as a key lithologic marker quartzite bed in a predominantly carbonate sequence, it is useful to show its distribution and structural displacement. Wernicke (1982) noted that Anita Harris of the U.S. Geological Survey had identified Upper Ordovician conodonts, typical of the lower Ely Springs Dolomite, in the Eureka Quartzite in the central Mormon Mountains. Thus, the "Eureka" there is likely reworked Eureka sand in the lower part of the Ely Springs Dolomite. This may also be the case in the Tule Springs Hills, but may not be the case in the adjacent Scarecrow Peak Quadrangle (Hintze and Axen, 1995). Eureka Quartzite is 3-8 m thick.

Pogonip Group (Middle and Lower Ordovician) The Pogonip Group has been divided into several formations that can be traced over most of west-central Utah and central Nevada (Hintze, 1951, 1952). However, because of facies changes, these formations cannot be identified in southeastern Nevada, and not enough systematic regional stratigraphic study has been done on the Ordovician rocks in this area to warrant establishing formal formational nomenclature. Hence, we use two informal mapping units, Opu and Opl, for the Pogonip Group.

Opu **Upper part (Middle and Lower Ordovician)** Predominantly yellowish-gray, silty, thin-bedded dolomite in the lower three-quarters; upper quarter is mostly medium-dark-gray calcarenite that contains poorly preserved oncolites and broken or poorly preserved remains of trilobites, brachiopods, echinoderms, and gastropods. Hintze and Axen (1995) described a 150-m section of upper Pogonip in the adjacent Scarecrow Peak Quadrangle where fossils are more abundant and better preserved. In section 3, T10S, R70E, 3 km south of the Lime Mountain Quadrangle, unit Opu is 163 m thick.

Opl **Lower part (Lower Ordovician)** Upper 98 m is mostly light-bluish-gray, thin- to medium-bedded, silty, unfossiliferous dolomitic limestone; lower 207 m is light- to medium-bluish-gray, streaked with yellowish-gray, fine-grained, medium-bedded, unfossiliferous dolomite that contains about 1% light-brown, bedded chert; forms low ledges. Unit Opl thickens westward across the Tule Springs Hills from about 135 m, at the southeast edge of the quadrangle, to 305 m in its south-central part, as described above.

OꞒm **Tectonic melange of Bonanza King, Nopah, and Pogonip Formations (Ordovician and Cambrian deposition, Cretaceous tectonism)** Exposed in a large area on the north edge of the map; consists of breccia and a mixture of boulder- and larger-size blocks derived from Cambrian and Ordovician units, locally incorporating a few chips of red Jurassic siltstone. Consolidation ranges from weak to completely recemented with carbonate and ferruginous carbonate with carbonate and ferruginous carbonate. Carbonate blocks are hydrothermally altered locally.

Ꞓn **Nopah Dolomite (Upper Cambrian)** Upper half (60 m) is a dark-gray, coarse-grained, thick-bedded to massive, locally cherty dolomite that is commonly mottled and includes white dolomite flecks. Lower half (60 m) is mostly light-gray, thick-bedded dolomite with 30% interbeds of medium-dark-gray, mottled dolomite. Nopah Dolomite forms ledges and cliffs. Lower Nopah is well-exposed on the northwest side of the large hill in section 14, T9S,R70E, where silicified brachiopods are found on the hilltop 8 m above the base of the upper dark-gray portion of the formation. Paleontologist James H. Stitt (written commun., November 1998) identified these fossils as *Billingsella texana* (Bell and Ellinwood, 1962) and stated that they are characteristic of the Taenicephalus trilobite zone of the middle part of the Late Cambrian Franconian stage in the United States. Total thickness of the Nopah Formation in the quadrangle is about 120 m.

Ꞓd **Dunderberg(?) Sandstone (Upper Cambrian)** Light- to dark-brown laminated sandstone with minor cross-bedding and interference ripple-marks; thickness 1-2 m. Although its thickness is not great, we have chosen to show it as a separate unit on the map because it is an important marker bed in a mostly carbonate sequence; it commonly shows as a dark ledge on aerial photographs. Dunderberg is the name orginally applied to an Upper Cambrian fossiliferous shale in the Eureka mining district of central Nevada (Wilmarth, 1938). Within the past few decades it has been used by mappers for various different horizons in the mostly unfossiliferous Upper Cambrian carbonate sequences in southern Nevada. In the Lime Mountain Quadrangle the unit that Axen (1991) mapped as Dunderberg is a sandstone and we have designated it as such in the title in order to emphasize that is not the same as the Dunderberg of central Nevada, nor is it the same as the Dunderberg Formation mapped by various geologists elsewhere in southern Nevada. Axen and others (1990) elucidated its usage as a map unit in the nearby Mormon Mountains.

Ꞓb **Bonanza King Formation (Upper and Middle Cambrian)** Consists of layers of light- and dark-gray dolomite in various thickness proportions. The light-gray dolomite is commonly laminated algal boundstone; the darker gray beds are commonly mottled with bioturbation burrows. The base of the Bonanza King Formation is not present in this quadrangle. Axen (1991) mapped subunits of the formation at the scale of 1:12,000; we combined his subunits on the present 1:24,000 map to avoid clutter. Detailed description of Bonanza King subunits is presented only by Wernicke (1982), in an unpublished dissertation. Well-exposed, unfaulted, partial sections of Bonanza King in this quadrangle are easily accessible on the west side of section 15, T9S, R70E, where the upper 200 m of unit Cb is exposed. In the Mormon Mountains, where the entire Bonanza King Formation is exposed, it is about 770 m thick (Wernicke, 1982). Maximum thickness above the thrust in this quadrangle is probably no more than 350 m.

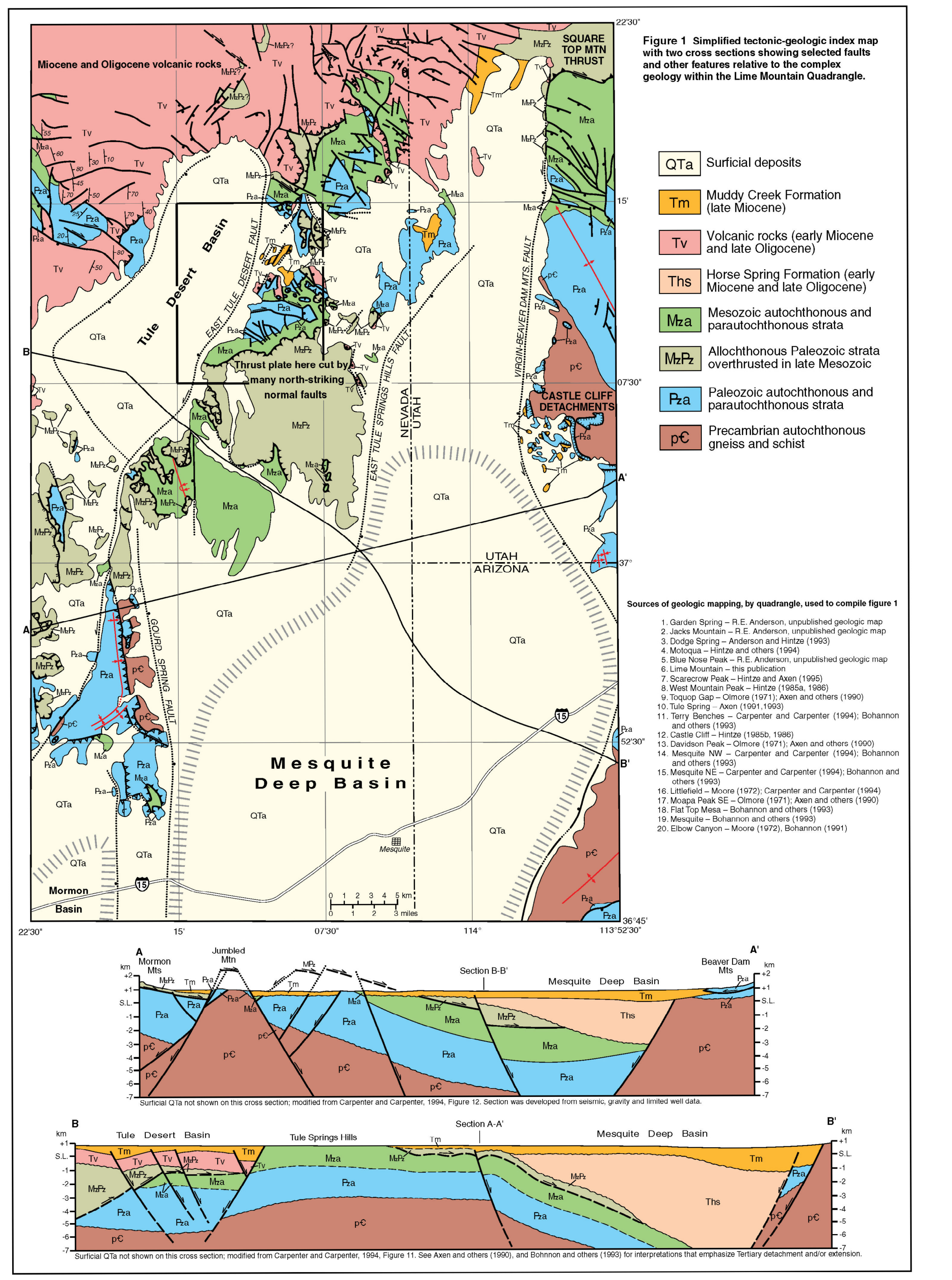
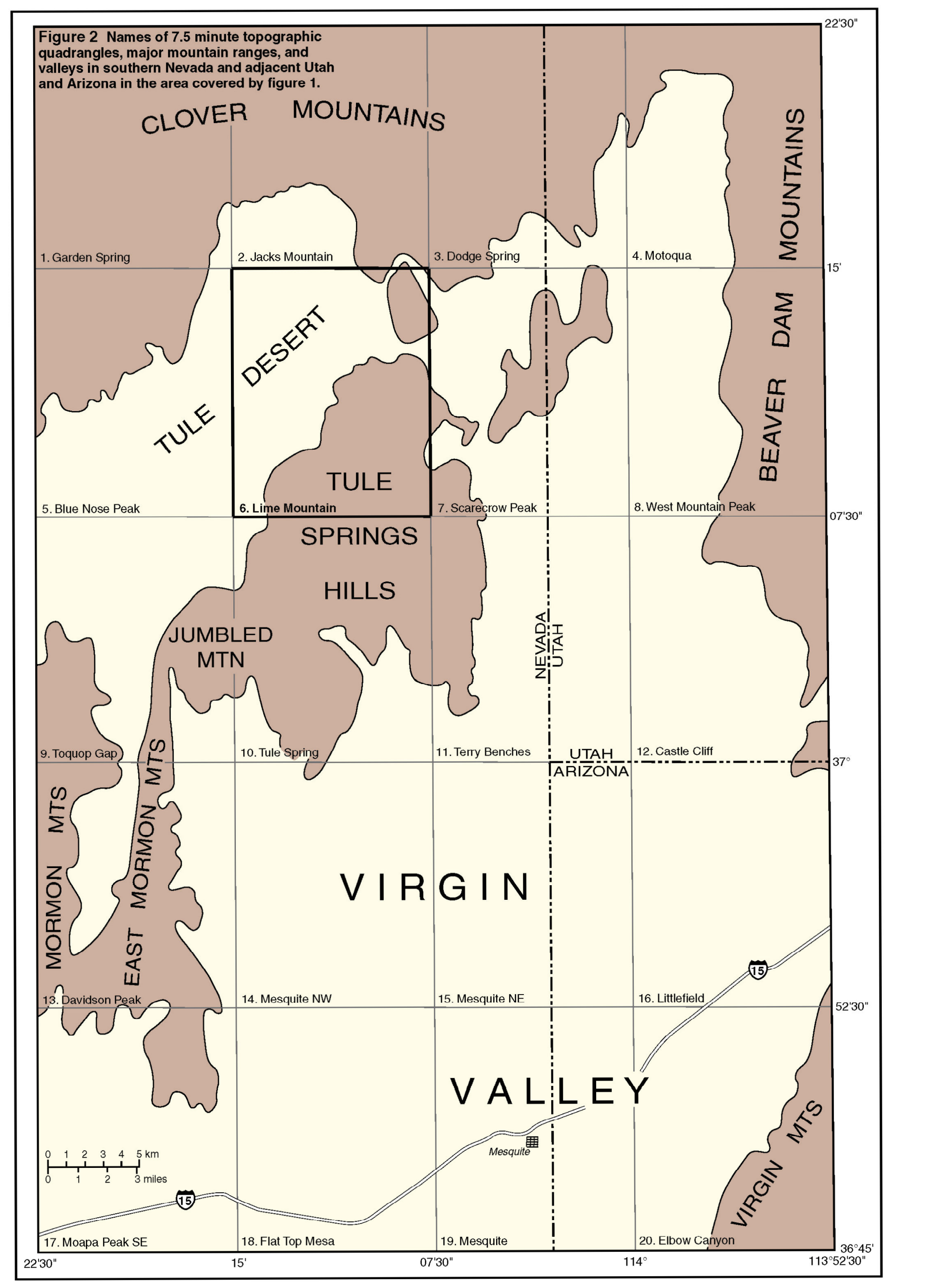

22'30"
15'
07'30"
37°
52'30"
36°45'
22'30"
15'
07'30"
114°
113°52'30"
Miocene and Oligocene volcanic rocks
SQUARE TOP MTN THRUST
Tule Desert Basin
EAST TULE DESERT FAULT
Thrust plate here cut by many north-striking normal faults
EAST TULE SPRINGS HILLS FAULT
NEVADA UTAH
VIRGIN-BEAVER DAM MTS. FAULT
CASTLE CLIFF DETACHMENTS
UTAH ARIZONA
GOURD SPRING FAULT
Mesquite Deep Basin
Mesquite
Mormon Basin
15
0 1 2 3 4 5 km
0 1 2 3 miles
A
A'
B
B'
QTa Surficial deposits
Tm Muddy Creek Formation (late Miocene)
Tv Volcanic rocks (early Miocene and late Oligocene)
Ths Horse Spring Formation (early Miocene and late Oligocene)
Mza Mesozoic autochthonous and parautochthonous strata
MzPz Allochthonous Paleozoic strata overthrusted in late Mesozoic
Pza Paleozoic autochthonous and parautochthonous strata
pꞒ Precambrian autochthonous gneiss and schist
A
A'
Mormon Mts
Jumbled Mtn
Section B-B'
Mesquite Deep Basin
Beaver Dam Mts
km
+2
+1
S.L.
-1
-2
-3
-4
-5
-6
-7
Surficial QTa not shown on this cross section; modified from Carpenter and Carpenter, 1994, Figure 12. Section was developed from seismic, gravity and limited well data.
B
B'
Tule Desert Basin
Tule Springs Hills
Section A-A'
Mesquite Deep Basin
Surficial QTa not shown on this cross section; modified from Carpenter and Carpenter, 1994, Figure 11. See Axen and others (1990), and Bohnnon and others (1993) for interpretations that emphasize Tertiary detachment and/or extension.

Figure 1 Simplified tectonic-geologic index map with two cross sections showing selected faults and other features relative to the complex geology within the Lime Mountain Quadrangle.

Sources of geologic mapping, by quadrangle, used to compile figure 1

1. Garden Spring – R.E. Anderson, unpublished geologic map
2. Jacks Mountain – R.E. Anderson, unpublished geologic map
3. Dodge Spring – Anderson and Hintze (1993)
4. Motoqua – Hintze and others (1994)
5. Blue Nose Peak – R.E. Anderson, unpublished geologic map
6. Lime Mountain – this publication
7. Scarecrow Peak – Hintze and Axen (1995)
8. West Mountain Peak – Hintze (1985a, 1986)
9. Toquop Gap – Olmore (1971); Axen and others (1990)
10. Tule Spring – Axen (1991,1993)
11. Terry Benches – Carpenter and Carpenter (1994); Bohannon and others (1993)
12. Castle Cliff – Hintze (1985b, 1986)
13. Davidson Peak – Olmore (1971); Axen and others (1990)
14. Mesquite NW – Carpenter and Carpenter (1994); Bohannon and others (1993)
15. Mesquite NE – Carpenter and Carpenter (1994); Bohannon and others (1993)
16. Littlefield – Moore (1972); Carpenter and Carpenter (1994)
17. Moapa Peak SE – Olmore (1971); Axen and others (1990)
18. Flat Top Mesa – Bohannon and others (1993)
19. Mesquite – Bohannon and others (1993)
20. Elbow Canyon – Moore (1972), Bohannon (1991)

Figure 2 Names of 7.5 minute topographic quadrangles, major mountain ranges, and valleys in southern Nevada and adjacent Utah and Arizona in the area covered by figure 1.



GEOLOGIC MAP OF THE LIME MOUNTAIN QUADRANGLE, LINCOLN COUNTY, NEVADA

Lehi F. Hintze and Gary J. Axen

2001