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Geology of Good Sight Mountains and Uvas Valley, southwest New Mexico

by R. E. CLEMONS

New Mexico Bureau of Mines & Mineral Resources

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Preface

This report on the geology of the Good Sight Mountains and Uvas Valley is another in a series of studies of the Rio Grande rift and adjacent uplifts between Caballo and Las Cruces. These geologic investigations, started in 1967, provide the foundation and essential background for all further investigations of the region's mineral resources, geothermal, soil, and ground-water potentials, as well as the feasibility of construction activities. These studies also provide a basis for correlating rocks in uplifts adjacent to the Rio Grande with those mapped in the southern Black Range and Cooke's Range to the west. Parts of the area have been shown on small-scale regional maps, but the detailed geology has not been previously published, partly because topographic maps for the southern part of the area were not published until 1972.

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Las Cruces, New Mexico
December 1978

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Abstract

The 435-sq-mi area described by this report includes the Good Sight Mountains and the Uvas Valley in Luna, Doña Ana, and Sierra Counties, New Mexico; the geologic map covers the western part of the Good Sight-Cedar Hills volcano-tectonic depression of Oligocene age. The Sierra de las Uvas on the east and the Good Sight Mountains on the west border the north-plunging Uvas Valley syncline, near the western side of the depression. Rock units exposed in the area range from Eocene to Holocene. The Good Sight Mountains are composed chiefly of Rubio Peak Formation rocks, which include latite and andesite tuffs, breccias, flows, dikes, plugs, and stocks with minor interbedded conglomerate and volcaniclastic beds. The source of these rocks was the Good Sight Mountains vent zone, which trends north for about 30 mi and is 4 mi wide. The Rubio Peak is correlative, in part, with the Palm Park Formation to the east, but may include some younger units. The Rubio Peak is unconformably overlain by tuff 6 and the upper sedimentary member of the Bell Top Formation on the eastern slopes of the Good Sight Mountains. Tuff 4, tuff 5, and the middle sedimentary member pinch out under the eastern part of the Uvas Valley. North of Nutt Mountain, Rubio Peak is overlain by Kneeling Nun Tuff or Tenaga Canyon (new name) andesites and latites, which intrude and overlie the Kneeling Nun. Uvas Basaltic Andesite flows are interbedded and overlie the upper sedimentary member of the Bell Top Formation on the west flank of the Sierra de las Uvas, under the Uvas Valley, and on the eastern flank of the Good Sight Mountains. Tenaga Canyon rocks are intruded and overlain locally by Uvas Basaltic Andesite. Nutt Mountain is a flow-banded rhyolite plug that intruded rocks as young as Tenaga Canyon formation. Quaternary clastic deposits, locally more than 300 ft thick, fill the Uvas Valley and extreme western part of the map area (eastern edge of the Mimbres Basin). Numerous water wells have penetrated these deposits and many of these wells bottom in the underlying Uvas and upper Bell Top Formation strata. Outcrops of the lower aquifers in the Sierra de las Uvas probably provide some recharge to the Nutt-Hockett Underground Water Basin.

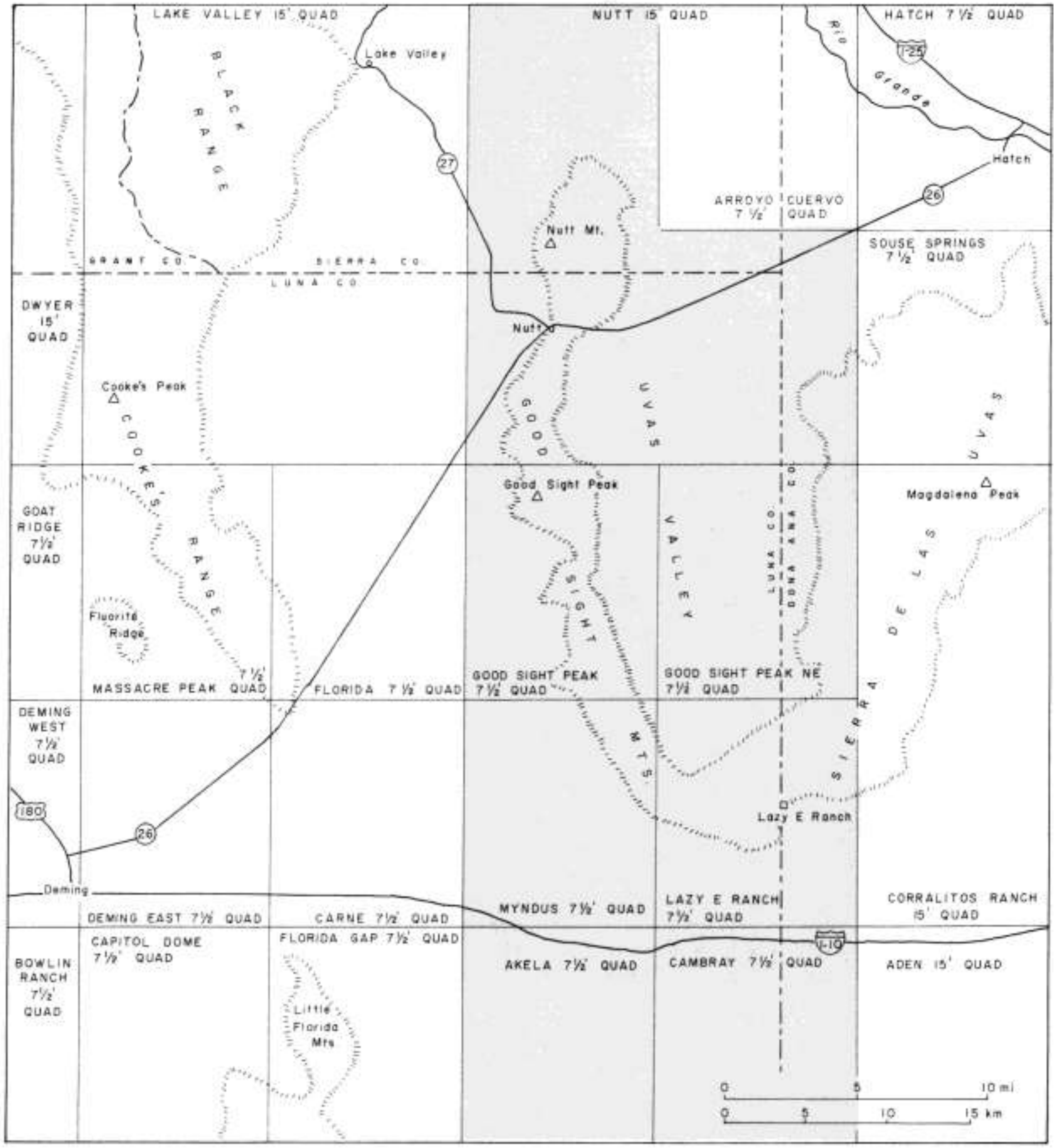

FIGURE 1—Location maps.

Introduction

This report covers an area of about 435 sq mi in northeastern Luna County, northwestern Doña Ana County, and southwestern Sierra County. The map area includes the Lazy E Ranch, Myndus, Good Sight Peak, and Good Sight Peak NE 7 1/2-minute quadrangles, as well as the southern half and northwest quarter of the Nutt 15-minute quadrangle (fig. 1). This area is in the northern part of the Mexican Highlands section of the Basin and Range physiographic province (Fenneman, 1931, Thornbury, 1965). Access to the area is provided by ranch roads connecting with exits on I-10 between Las Cruces and Deming, NM-26 between Hatch and Deming, and NM-27 between Nutt and Lake Valley.

The northern end of the Good Sight Mountains are about 9 mi east-southeast of Lake Valley. From there they continue south for 30 mi, ranging from 3 to 5 mi in width. The southern end curves eastward, around the south end of the Uvas Valley, and connects with the southwestern prong of the Sierra de las Uvas (fig. 2) about midway between Las Cruces and Deming. Elevations range from high points of 5,940 ft at Nutt Mountain and 5,602 ft at Good Sight Peak in the northwestern part of the area and 5,500 ft on the west flank of the Sierra de las Uvas in the northeast part to a low point about 4,140 ft near Myndus in the southwest corner. Peaks along the crest of the Good Sight Mountains are mostly between 4,700 and 5,100 ft toward the south (fig. 3) and 5,000 and 5,600 ft toward the north. Elevations of the Uvas Valley are between 4,460 and 4,600 ft. Thus, relief on the east flank of the mountains is 300-500 ft less than on the bold western escarpment.

Footslopes extending 3-6 mi southwestward away from the base of the range into the Mimbres Basin are broad pediments (fig. 4). Quaternary fan gravels of variable thicknesses and eolian sand mantle the undissected pediment. That only a few small exposures of bedrock occur more than a mile from the main mass of the mountains (fig. 5) provides evidence for the thorough pediment development and thin pediment cover. Bedrock was recorded at 200-ft depths in two water wells near Akela, about 5 mi southwest of the Good Sight Mountain escarpment. The pediment narrows northward to less than 0.5 mi northwest of Good Sight Peak where Macho Arroyo hugs the mountains. At this point, broad pediment and alluvial fan deposits rise westward for about 11 mi to the southern Cooke's Range. Interior drainage covers the map area except in the extreme northeast and northern parts where arroyos are tributary to the Rio Grande.

Most of the area is sparsely vegetated grazing land (figs. 2, 3, and 4). Grass cover improves in the northwest part of the area; elsewhere shrubs are dominant, mainly creosote bush, mesquite, yucca, snakeweed, and various cacti. A few juniper dot the higher elevations. The Uvas Valley is in the Nutt-Hockett Underground Water Basin, designated as a closed basin by the State En-

FIGURE 2—SIERRA DE LAS UVAS VIEWED FROM THE SOUTHWEST. Massacre Peak in upper left capped with Uvas Basaltic Andesite; pediment in foreground on conglomeratic middle sedimentary member of the Bell Top Formation.

FIGURE 3—WESTERN ESCARPMENT OF GOOD SIGHT MOUNTAINS. Gentle pediment slope merges into basin floor (elev. 4,200 ft) at northeast side of Mimbres Basin; highest peak on center skyline is 5,123 ft.

FIGURE 4—BROAD PEDIMENT WITH THIN COVER RISES GENTLY TO SOUTHWESTERN ESCARPMENT OF GOOD SIGHT MOUNTAINS. Ledges and cliffs of Rubio Peak andesite cap about 500 ft of tuff breccia.

FIGURE 5—SMALL OUTCROP OF HORNBLENDE LATITE PORPHYRY SURROUNDED BY BASIN-FLOOR DEPOSITS (Qbf) about 2 mi west of Good Sight Mountains, 0.8 mi northeast of Fox Well in the Myndus quadrangle.

gineer. In the valley irrigation wells provide water for farming, which produces crops of lettuce, onions, chile, alfalfa, cotton, and occasionally wheat.

The geology of the area has been shown only on regional and state geologic maps (Dane and Bachman, 1961, 1965; Darton, 1922, 1933; Lindgren and others, 1910), and little geologic work was done in the area prior to that summarized in this report. Parts of the area are shown on maps by Dunham (1935) and Darton (1916). No other regionally significant work was published until Jicha (1954) and Elston (1957) mapped the Lake Valley and Dwyer quadrangles, respectively, to the northwest. Several field trip guidebooks (Kottlowski, 1953a, 1958; Hawley and Kottlowski, 1965; Donegan and others, 1965; Hawley and others, 1975) contain notes on the geology of the area. Studies of the Rio grande rift and adjacent uplifts were started in 1967. These studies (Seager and others, 1971, 1975, 1976; Seager, 1973, 1975a; Clemons and Seager, 1973; Seager and Hawley, 1973; Clemons, 1976a, 1977; Hawley, 1978) have provided continuous detailed maps from the east side of the Rio Grande westward to the present map area.

Stratigraphy

Rock units exposed in the map area range from Eocene to Holocene. The volcanic and volcaniclastic rocks underlying the eastern half of the area have been described in detail by Clemons and Seager (1973), Seager and others (1975), and Clemons (1975, 1976a, 1976b, 1977) during studies to the east. Several of the units wedge out in the western Sierra de las Uvas and under the Uvas Valley.

The Good Sight Mountains, south of Nutt, are composed mainly of rocks belonging to the Rubio Peak Formation (late Eocene-early Oligocene). Darton (1916, 1917) described these rocks as agglomerates. Tuffs and breccias are the dominant rock type in many sections, but andesite and latite flows, dikes, plugs, and stocks are important members and minor amounts of tuffaceous sandstone and conglomerate are present. Thus they resemble the Rubio Peak Formation named by Elston (1957) in the Dwyer quadrangle and also mapped by Jicha (1954) in the Lake Valley quadrangle (fig. 1). A notable difference is the apparently greater abundance of intrusive rocks in the Good Sight Mountains.

The Rubio Peak Formation probably overlies Permian rocks. The closest exposures of its base are about 10 mi northwest of the map area in the Hillsboro quadrangle (Hedlund, 1977), where it unconformably overlies the Abo Formation of Permian age. In Cooke's Range, 15 mi to the west, and the Florida Mountains, 20 mi to the southwest, it unconformably overlies rocks as young as Cretaceous and Permian. About 15 mi to the east, partly correlative Palm Park beds overlie Permian rocks (Clemons, 1976a). On the eastern slopes of the Good Sight Mountains, the Rubio Peak is unconformably overlain by tuff 6, the upper sedimentary member of the Bell Top Formation, and Uvas Basaltic Andesite. North of Nutt Mountain, Rubio Peak is overlain by Kneeling Nun Tuff or andesites and latites of the Tenaga Canyon formation (new name), which intrudes and overlies the Kneeling Nun. The Tenaga Canyon is intruded and overlain locally by Uvas Basaltic Andesite. Nutt Mountain is a flow-banded rhyolite plug that intruded rocks as young as the Tenaga Canyon formation.

Quaternary clastic deposits, locally more than 300 ft thick, fill the Uvas Valley and extreme western part of the map area. Only the youngest beds are exposed within the map area, except in the northeastern corner, but the complete section has been penetrated by many water wells in the Uvas Valley. These deposits, overlying the Rincon Valley Formation (of the Santa Fe Group), are well exposed in several arroyos in the Arroyo Cuervo quadrangle (fig. 1) and are described in appendix 1. They overlap all older rock units with angular unconformity.

Palm Park Formation (Tpp)

Rocks underlying the Bell Top Formation in the eastern part of the Lazy E Ranch quadrangle (fig. 1) are mapped as Palm Park Formation (Kelley and Silver, 1952). Dunham (1935) and Darton (1928) briefly mentioned these rocks in the southern Caballo Mountains and Sierra de las Uvas, respectively. Seager and Hawley (1973) described type and supplemental section that include grayish-red, tuffaceous mudstone and siltstone with cyclically interbedded purple andesite cobble-boulder conglomerate and brown to gray andesite-plagioclase sandstone. The middle part of the formation contains lenticular fresh-water limestone and associated travertine deposits. They stated that "the lithologic assemblage suggests hot spring, stream, floodplain and possible mudflow deposition on piedmont slopes draining andesitic volcanic highlands."

This unit has been extended southward from its type locality in the southern Caballo Mountains around the eastern flank of the Sierra de las Uvas during recent mapping (Seager and others, 1971; Clemons and Seager, 1973; Seager and Hawley, 1973; Seager and others, 1975; Clemons, 1976a, 1977). Within the present map area, the Palm Park consists of grayish-red, grayish-purple, brown, and gray conglomeratic volcanic arenites of andesite-latite composition. North of Radium Springs the Palm Park is composed of laharic breccia with boulders up to 10 ft in diameter embedded in a tuffaceous matrix (Seager, 1975a). The boulder size and content decreases westward with a corresponding increase in the degree of bedding, sorting, and rounding. Similarly the Rubio Peak Formation in the Good Sight Mountains contains a tuff-breccia unit with angular boulders up to 20 ft across in a tuffaceous matrix (fig. 6). This unit appears to grade eastward to smaller grain sized, more rounded, better bedded, and better sorted deposits.

One of the major problems in the area is distinguishing Palm Park from Rubio Peak. These units apparently are partly correlative but derived from different sources whose distal alluvial facies intertongue, although the Rubio Peak probably contains some younger rocks. Some sediments of each formation may have been reworked and caused mixing within individual units. In addition, the massive, thick-bedded alluvial deposits erode to typically rounded hills and subdued slopes with very few exposures.

Four potassium-argon ages on the Palm Park and equivalent rocks to the east range from 35.9 to 51.5 m.y. A plagioclase separate from a sample of Cleofas andesite in the Doña Ana Mountains yielded an age of 35.9 ± 1.6 m.y., which appears to be too young. Biotite from an andesite porphyry collected at the southeastern end of San Diego Mountain yielded an age of 42.2 ± 1.6 m.y.

FIGURE 6—POLYLITHIC TUFF BRECCIA. Clasts consist of dense or vesicular andesite and dense basalt(?) in a lapilli tuff matrix; well-exposed in arroyo northeast of Mountain windmill.

Kottlowski and others (1969) reported an age of 43 m.y. on an andesite from the Palm Park in the southern Robledo Mountains. An andesite porphyry in the East Selden Hills yielded an age of 51.5 ± 2.6 m.y. on a hornblende separate. This age may be too old. Two potassium-argon ages (37.6 ± 2.0 m.y. on hornblende and 38.1 ± 2.0 m.y. on biotite) from two separate samples of Rubio Peak andesite and latite porphyry in the Good Sight Mountains fall within this range. The arbitrary boundary between the two formations for mapping purposes is the valley by the Lazy E Ranch headquarters on the Dona. Ana-Luna County line (fig. 1).

Rubio Peak Formation

The Rubio Peak Formation (Elston, 1957) in the Good Sight Mountains consists of biotite-hornblende latite-andesite volcaniclastic rocks, flows, dikes, plugs, and small stocks. Its characteristic aspect is basically twofold. Thick units (600 ± ft) of poorly stratified, light- to medium-gray tuff breccias grade into well-stratified tuffaceous breccias, conglomerates, and coarse fluvial sandstone away from the vents. Of about equal significance are massive intrusive-extrusive complexes of dense, light- to medium-gray, pale-brown, and grayish-red-purple latite-andesite. Several dikes and small stocks of latite porphyry intrude all the above rocks. The Rubio Peak has been divided into seven mapping units in the Good Sight Mountains.

Conglomerate and breccia (Trc)

The extreme southeastern end of the Good Sight Mountains is composed of a cobble-boulder conglomerate with minor interbedded tuffaceous sandstone lenses. This unit grades and intertongues downward and northwestward into poorly bedded tuff breccia, which was part of its source area. These alluvial facies deposits are the lateral time equivalents of some of the vent facies deposits. The only exposures of the fluvial facies are in small gullies on the low rounded hills, which are strewn with residual latite-andesite cobbles and boulders. A minimum thickness of about 1,500 ft is estimated to be present in these hills.

A poorly cemented tuffaceous sandstone, probably part of the middle sedimentary member of the Bell Top Formation, overlies the conglomerate west-northwest of the Lazy E Ranch headquarters. The base of the conglomerate unit is not exposed, and the dashed contact line separating it from tuff breccia on the geologic map was arbitrarily drawn between areas where one or the other predominates.

Similar rocks underlie the Kneeling Nun Tuff north of Nutt Mountain. Here also, these deposits are the least resistant to erosion and typically form subdued slopes. They underlie the lower slopes and are not well exposed. The slopes are covered with residual latite-andesite boulders up to 2 ft across after the poorly cemented sandy matrix is eroded.

FIGURE 7—MONOLITHIC TUFF BRECCIA. Clasts are hornblendebiotite latite with minor matrix of same composition. Forms slope beneath massive andesite-latite 1 mi west of Mountain windmill at western edge of Lazy E Ranch quadrangle.

Tuff breccia (Trt)

Tuff breccia is used here as a nongenetic term for rocks in which abundant blocks and lapilli lie in a tuffaceous matrix that composes at least 25 percent of the rock (Lydon, 1968). It is used in preference to the genetic terms: laharic breccia, vent breccia, talus breccia, or water-laid volcanic breccias as defined by Fisher (1960). The tuff breccia map unit probably includes all of these genetic types of breccias in the Good Sight Mountains, but laharic breccia predominates. Darton (1916) referred to these rocks in the northern Good Sight Mountains as "agglomerate," but in recent years the term agglomerate has taken on the connotation of agglutinated volcanic bomb deposit. Lasky (1940) referred to similar and probably correlative rocks in the northern Florida Mountains as "fanglomerate."

Excellent exposures of the tuff breccia can be seen in the west-facing steep slopes and cliffs of the Good Sight Mountains from Mountain windmill (fig. 7) in the Lazy E Ranch quadrangle north to Good Sight Peak. Along the southwestern escarpment of the Good Sight Mountains, the dominant type is a polylithic breccia containing angular clasts of two or more latite-andesites ranging in size from granules to 20-ft boulders (fig. 8). These compose 50-75 percent of the rock with a yellowish-gray, tuffaceous matrix rich in plagioclase, hornblende, and biotite crystal fragments. A second, not so widespread type is a monolithic breccia containing similar-sized angular clasts of light-gray, biotite-hornblende latite porphyry in a tuffaceous matrix of the

FIGURE 8—POLYLITHIC TUFF BRECCIA. Clasts of several types of andesite and latite. Predominant slope-former along southwestern escarpment of Good Sight Mountains.

same composition (figs. 7 and 9). This breccia is well exposed along much of the western escarpment of the Good Sight Mountains. Toward the east, and probably overlying the monolithic tuff breccia, another dark-gray tuff breccia is exposed in the arroyo and slopes northeast of Mountain windmill (fig. 7). The clasts in this breccia are predominantly dark-gray to black, vesicular and dense, andesite and basaltic andesite contained in a light- to medium-gray tuffaceous matrix.

At least several hundred feet of light-gray hornblende-latite tuff breccia and lenses of sandy conglomerate crop out sporadically in the western slopes in the vicinity of Nutt. About 30 ft of a representative section is exposed in the railroad cut east of Nutt (fig. 10). The clasts in the tuff breccia are medium gray, porphyritic hornblende latite. The dominant rock type contains about 16-percent hornblende phenocrysts (up to 7.5 mm long), 7-percent andesite (An_{45}) phenocrysts (up to 2mm long), 1-percent hypersthene phenocrysts (less than 1 mm long)

FIGURE 9—MONOLITHIC LAHAR OR TALUS BRECCIA CAPS SMALL HILL 0.8 MI NORTH OF GOOD SIGHT WELL, near southern edge of Good Sight Peak quadrangle. No bedding is present in about 100 ft of tuff breccia which overlie an air-fall tuff.

FIGURE 10—BEDDING PLANE BETWEEN TWO MASSIVE-BEDDED LAHAR(?) UNITS EXPOSED IN RAILROAD CUT EAST OF NUTT.

FIGURE 11—WELL-BEDDED SECTION OF CONGLOMERATE AND BRECCIA OVERLAIN BY ANDESITE FLOW AND UNDERLAIN BY MASSIVE TUFF BRECCIA, near eastern edge of Myndus quadrangle. These relations represent intertonguing of vent and alluvial facies.

in a vesicular, hyalopilitic pilotaxitic matrix of plagioclase laths, mafic mineral grains, and glass.

Generally throughout several hundred feet of section no bedding is evident in the tuff breccias (mostly laharic breccias); sorting is lacking; and elongate boulders appear to have no preferred orientations. A few thin beds and lenses of tuffaceous sandstone are interbedded in the breccias. These bedded deposits have mostly gentle (3-6 degrees) easterly or northeasterly dips throughout the length of the Good Sight Mountains. Easterly dips of 15-24 degrees are present close to what were apparently larger vents. No westerly or southerly dips are present. A well-bedded section several hundred feet thick in secs. 14 and 23, T. 22 S., R. 6 W. in the central Good Sight Mountains and locally bedded outcrops (fig. 11) are included in the tuff breccias because they grade laterally into poorly bedded, more massive units and are not abundant enough to justify mapping separately.

The tuff breccias closely resemble andesite tuff breccias described by Durrell (1944), Curtis (1954), and Lydon (1968) in California; by Rouse (1937), Parsons (1958, 1960), and Smedes and Prostka (1972) in the Absaroka volcanic field of Wyoming; and by Epis and Chapin (1968) in the Thirtynine mile volcanic field of central Colorado. The earlier authors suggested most of the tuff breccias in their areas of study were the result of eruptive mudflows. Brecciation of viscous magma within near-surface vents resulted from either violent escape of gas (Durrell, 1944) or from spalling and attrition accompanying vesiculation of viscous magma (Curtis, 1954). Hot mudflows, subjected to high hydrostatic pressure, are then erupted and move downslope away from the vents. These rocks are often referred to as the "vent facies" (fig. 12). Lahars (volcanic mudflows) resulting from rainfall saturating loose debris on volcanic slopes probably are equally as important in forming various tuff breccias in the Good Sight Mountains.

Intrusive breccia (Trib)

Several northwest- to northeast-trending ridges composed of brecciated, dense, greenish-gray to medium-gray latite-andesite are mapped in the southern half of the Good Sight Peak quadrangle. They are each approximately 0.5 mi long and 0.1 to 0.2 mi wide. The intrusive breccias grade quite abruptly into unbrecciated rock of the same composition. Close examination is required to see the vertical sheeting and alignment of small plagioclase and hornblende crystals. Some zones contain angular fragments that have been rotated and crushed, producing fine matrix material (fig. 13). These zones grade downward and outward into zones of breccia in which the fragments are still interlocked in their primary positions. These rocks sporadically may be seen grading into unbrecciated rock.

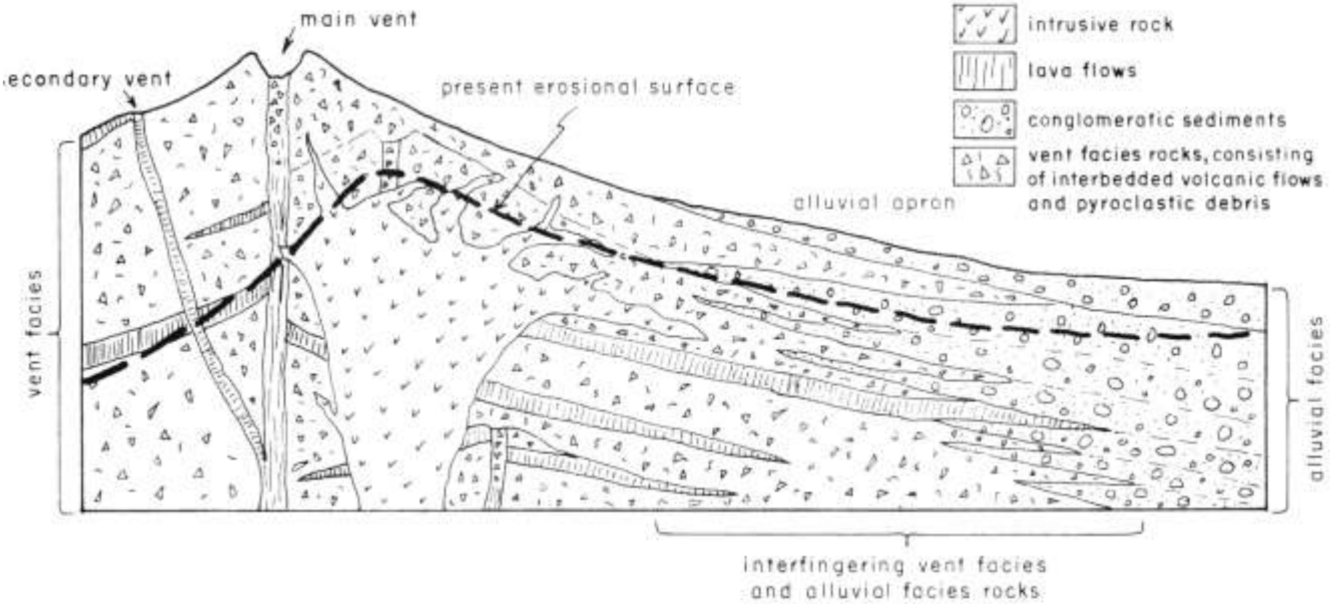

FIGURE 12—HYPOTHETICAL SECTION OF GOOD SIGHT MOUNTAINS VENT ZONE. Vent facies: rocks composing part of original vent zone. Alluvial facies: well-bedded volcanic sediments deposited as a sheet of reworked debris on east flank of vent zones.

Flow breccia (Trb)

A third kind of breccia present in the Good Sight Mountains is a monolithic breccia of dense, nonvesicular, greenish-gray, grayish-purple, and reddish-brown andesite-latite. Smooth-surfaced, very angular equidimensional blocks range in size from granules to 4-ft boulders. As a unit this rock is darker colored than the tuff breccia and is readily distinguished from monolithic tuff breccias by the small amount of fine-grained interstitial matrix, averaging less than 10 percent in the flow breccias. The flow and intrusive breccia is similar in appearance. Unless the base of the breccia is exposed for some lateral distance the outcrop was not included in the flow-breccia map unit. This breccia forms small (less than 0.1 mil) outcrops that are near or adjacent to intrusions. Most of these outcrops are probably autobrecciated flows.

Intrusive porphyries (Trip)

Eleven or twelve small stocks and dikes of hornblende-biotite latite porphyry crop out along the western front of the Good Sight Mountains. The stocks range in size from 0.15 to almost 1.0 mi across. The dikes are about 50-100 ft wide and up to a mile in length of exposure. One small isolated outcrop (fig. 5), northeast of Fox Well in the Myndus quadrangle, is 2 mi west of the main mountain front. The number of dikes or stocks covered by the pediment gravels is unknown, but there is a high probability that several exist.

The rocks contain 27-47 percent phenocrysts of plagioclase, hornblende, and biotite (up to 5 mm long) in a matrix of acicular and blocky plagioclase laths, hornblende, biotite, magnetite, secondary carbonate, and cryptocrystalline material. The dominant phenocrysts (19-31 percent of the rock) are oscillatory and progressively zoned plagioclase. They are mostly fresh-appearing, euhedral, twinned crystals of sodic andesine, but some contain dark altered cores or vermicular patches of clay, carbonate, and epidote(?). Euhedral hornblende phenocrysts (composing 5-15 percent of the rock) are slightly to strongly oxidized. The red to red-brown oxyhornblende invariably has thin to thick black rims of magnetite and hematite, and some phenocrysts have been completely replaced by biotite and iron oxides. Biotite, which composes 1-7 percent of the rocks, is in the form of thick hexagonal books. It is mostly a fresh-appearing, red-brown mineral, and the larger phenocrysts are poikilitic with plagioclase inclusions.

A potassium-argon age of 38.1 ± 2.0 m.y. was determined on a sample from the northwest side of the stock(?) 1 mi west of Good Sight Peak (C. E. Chapin, oral communication).

Nonporphyritic intrusives (Tri)

Dikes, sills(?), and irregular intrusive masses of dense, nonvesicular, nonporphyritic to slightly porphyritic

FIGURE 13—ANDESITE BRECCIA PLUG(?) IN LARGE INTRUSIVE-EXTRUSIVE COMPLEX ON UPPER SLOPES OF CANYON 0.4 MI NORTH OF GOOD SIGHT WELL. Slabby dense andesite flow rock in foreground.

andesite-latite are quite common in the Good Sight Mountains. Most of these are part of intrusive-extrusive complexes and their occurrence is described below. Only those rocks that could be clearly delineated as entirely intrusive material are mapped as nonporphyritic intrusions (Tri).

There are several mineralogic and textural varieties present in the map area, but a medium-gray hornblende andesite is the principal type. It contains 15-40 percent microphenocrysts (0.1-1.0 mm) of zoned plagioclase and hornblende set in a hyalopilitic matrix. Many of the stubby prismatic plagioclase crystals have frayed, embayed edges but are otherwise fresh-appearing. The hornblende is strongly oxidized and only outlines of some of the original euhedral crystals remain, because they were completely altered to iron oxides and biotite. The phenocrysts show an increase in size in the light-gray and grayish-red varieties, which are presumably more silicic because biotite is more abundant in these rocks. Rarely do phenocrysts larger than 1 mm compose more than 10 percent of the rock; they usually compose less than 4 percent. Microphenocrysts of augite are much less abundant and have only been seen in a couple of pale-brown varieties of andesite.

Undifferentiated flows and intrusions (Trfi)

Dense andesite-latite intrusive-extrusive complexes crosscut and interbed in almost all sections of the Rubio Peak Formation in the Good Sight Mountains. Volumetrically they are probably about equal in abundance to the tuff breccias. The complexes increase in size and abundance northward from Mountain windmill and are the dominant Rubio Peak rock type in the Good Sight Peak quadrangle and southwest quarter of the Nutt quadrangle; they diminish in size and abundance to the northern end of the mountains. Steep intrusive contacts can be seen in a few places, but in tracing out the contact the intrusion appears to become a flow or sill, concordant and interbedded with tuff breccia or older dense andesite-latite. Fig. 14 shows about 6 ft of breccia grading upward into an andesite flow.

The typical andesite-latite rocks of this map unit are either massive (with widely spaced, randomly oriented joints) or are foliated (with well-developed joints parallel to the foliation); the well-developed jointing of the foliated rocks promotes weathering to thin platy or slabby fragments. Along several contacts the intrusive rock is gradational into flow-banded rock and then into a vitrophyre zone up to several feet wide adjacent to the country rock. These relations are well exposed in the northeast quarter of sec. 25, T. 22 S., R. 6 W. The glass has an index of refraction of 1.505, indicative of a relatively high silica percentage. Some of the rocks may be dacites or rhyodacites. Elston (1957) and Jicha (1954) reported 59-62 percent silica with normative quartz (13-27 percent) and orthoclase (17-21 percent) for the Rubio Peak andesites and latites in the Dwyer and Lake Valley quadrangles.

FIGURE 14—RUBIO PEAK ANDESITE FLOW WITH THICK BRECCIATED BASAL ZONE. Flow caps ridge 0.4 mi north of Good Sight well.

Petrographically all the complexes are quite similar even though they appear to vary considerably in hand-specimen appearance. Normal and oscillatory-zoned plagioclase phenocrysts, ranging in size from 0.2 to 3.0 mm, compose up to 36 percent of the rocks. Their composition ranges from oligoclase (An_{28}) to labradorite (An_{55}), averaging about An_{40}. Euhedral oxyhornblende phenocrysts, ranging in size from 0.2 to 5.0 mm, make up another 2-16 percent of the rocks. The hornblende is typically intensely oxidized and largely replaced by magnetite, hematite, and some biotite. Wide dark-red to black rims are very common. A few of the rocks contain hornblende and biotite altering to chlorite. Euhedral to subhedral phenocrysts of augite and hypersthene, ranging in size from 0.1-0.8 mm, are present in most of the rocks but only rarely make up as much as 3 percent of the rocks. Biotite is usually present in trace amounts and one rock contained up to 1.5 percent. Pilotaxitic and hyalopilitic matrices are predominantly plagioclase laths, with hornblende, pyroxene, and magnetite microlites in brown glass and cryptofelsic material.

A potassium-argon determination on a hornblende separate from one of these rocks gave an age of 37.6 ± 2.0 m.y. The sample was collected in the SE 1/4 NW 1/4 sec. 22, T. 22 S., R. 6 W. and about 4 mi southeast of the Brownfield Ranch headquarters. The two ages determined on Rubio Peak rocks in the Good Sight Mountains are thus in close agreement. Seager and others (1978) reported an age of 37.1 ± 0.8 m.y. for the Rubio Peak. Potassium-argon dating of hornblende by D. C. Hedlund from a hornblende latite in the Rubio Peak near Emory Pass yielded an age of 36.4 ± 2.3 m.y. (written communication, 1977). Hedlund also had a plagioclase concentrate from an andesite porphyry in the southwest corner of the San Lorenzo quadrangle dated. This sample yielded an age of 32.6 ± 2.1 m.y., which is considered too young.

Bell Top Formation

The Bell Top Formation was defined by Kottlowski (1953b) as consisting of rhyolite tuffs, vitrophyre flows and dikes, flow-banded rhyolite flows and domes, interbedded with volcaniclastic rocks. Clemons and Seager (1973) measured and described a "composite type section" from exposures near Bell Top Mountain. Their report and subsequent studies (Seager and Hawley, 1973; Seager and others, 1975; Seager, 1975a; Clemons 1976a, 1977) have essentially delineated the extent, thicknesses, ages, and regional relationships of the Bell Top Formation. It has been divided into 13 informal members, including six ash-flow tuffs, Cedar Hills rhyolite, basaltic andesite, basalt, and four interbedded sedimentary units. All the members are not present in any one area. The petrology of all the units was described by Clemons (1975, 1976b).

Maximum thickness of the Bell Top is about 1,500 ft in the central Sierra de las Uvas. It crops out sporadically from Apache Canyon in the southern Caballo Mountains to the West Potrillo Mountains and from the Cedar Hills to the Good Sight Mountains, thinning radially away from the Sierra de las Uvas as the lower members pinch out. An exception to this generalization is on the eastern margin of Bell Top exposures, along the Cedar Hills vent zone (Seager, 1973), where it is still quite thick and most of the members are present. Several of the ash-flow tuffs interfinger with the Thurman Formation (Kelley and Silver, 1952) in the Rincon Hills. Thus the Bell Top was deposited over an approximately 1,400-mi^2 area that coincides with the Good Sight-Cedar Hills volcano-tectonic depression (Seager, 1973). The depression is floored by the Palm Park Formation to the east and the Rubio Peak Formation to the west.

Tuff 4 member (Tbt_4)

Tuff 4, the oldest member of the Bell Top Formation that crops out in the map area, is only present in the northeastern part of the Lazy E Ranch quadrangle and occurs as a thin (10-20 ft) sheet with low northwesterly dips. Its probable southwesternmost occurrence is covered with alluvial fan material northwest of Lazy E Ranch headquarters. Tuff 4 unconformably overlies Palm Park (or Rubio Peak?) conglomerate and is unconformably overlain by tuffaceous sandstone and conglomerate of the middle sedimentary member of the Bell Top Formation.

Near the Lazy E Ranch headquarters, tuff 4 is a grayish-red-purple, dense, vitric ash-flow tuff. About four percent of the rock is sanidine crystals with minor quartz and biotite set in a matrix of devitrified, axiolitic shards, magnetite, minute crystal fragments, and glass. The large, darkened, flattened pumice fragments so characteristic of tuff 4 at Bell Top Mountain and Broad Canyon are not present. In fact, tuff 4 only vaguely resembles the same unit at the type locality, which is less dense and contains up to 15 percent crystal fragments.

Tuff 5 member (Tbt5)

Tuff 5 does not crop out in the map area but is probably present in the subsurface and pinches out under the eastern side of the Uvas Valley (cross sections B'-B" and A'-A" on sheet 2). Tuff 5 is a moderately to highly welded, crystal-vitric ash-flow tuff. Sanidine, quartz, plagioclase, and biotite crystals average about 27 percent of the rock; shards are sparse. An age of 35.1 ± 1.3 m.y. was determined on biotite from tuff 5 sampled near Bell Top Mountain (Clemons and Seager, 1973).

Middle sedimentary member (Tbsm)

The low rounded hills in the northeast corner of the Lazy E Ranch quadrangle are composed of conglomerate, tuffaceous sandstone, and mudstone belonging to the middle sedimentary member. An estimated thickness of 300 ft is present here but it pinches out 6 mi to the west. Outcrops (fig. 2) are poor because of the nonresistant character of the unit. Clasts in the conglomerate appear to have been derived mainly from the Rubio Peak Formation to the west.

Poorly cemented sandstone exposed in arroyos approximately 2-3 mi west-northwest of the Lazy E Ranch is mapped as queried middle sedimentary member. It is composed of about 95-percent shards and clay with minor quartz, plagioclase, sanidine, and biotite fragments. Its sources are probably air-fall tuff and unwelded upper and distal parts of tuff 3(?) and tuff 4, possibly in the ancestral Good Sight Mountains. This sandstone overlies Rubio Peak conglomerate and breccia and is unconformably overlain by the upper sedimentary member of the Bell Top Formation. Tuff 6 separates the two sedimentary members about a mile to the north-northeast.

Tuff 6 member (Tbt_6)

Tuff 6 crops out about 3 mi north of Lazy E Ranch along the base of the slope marking the southern end of the Uvas Valley syncline. It continues across the southeastern corner of the Good Sight Peak NE quadrangle, by Massacre Peak, with gentle northwesterly dips. The southwestern termination of tuff 6 is covered by the same alluvial-fan material that buried the middle sedimentary member and distal edge of tuff 4. Thickness of tuff 6 exposed in this area ranges from 10 to 112 ft.

One small outcrop of ash-flow tuff northeast of Butterfield windmill, in the Good Sight Peak quadrangle, is mapped as queried tuff 6. About 100 ft of tuff was deposited in a paleovalley cut into Rubio Peak rocks and then covered by Bell Top upper sedimentary member and Uvas Basaltic Andesite. The petrography (appendix 2) and stratigraphic position of this tuff correlate well with tuff 6. Six additional outcrops of tuff 6 are mapped from 2.5 mi southeast of Nutt to 1.5 mi southeast of Nutt Mountain. Thicknesses of tuff 6 exposed in these sporadic outcrops range from 20 to 80 ft. Although the Good Sight Mountains were definitely still a relatively high area during eruption of tuff 6, it could conceivably have spilled through valleys and saddles and been deposited farther west. It is not present north of Nutt Mountain.

Tuff 6 is a pale red-purple to grayish-pink, moderately welded, crystal-vitric ash-flow tuff. Abundant light-gray pumice fragments are common constituents. Crystal fragments of plagioclase, sanidine, quartz, biotite, and trace amounts of hornblende compose about 20-30 percent of the rock. The groundmass is characterized by a microcrystalline mosaic of minute crystal fragments, axiolitic shards, glass, and magnetite.

An age of 36.5 ± 1.4 m.y. was obtained from biotite in tuff 6 collected in the eastern Sierra de las Uvas. This age appears to be too old because 1) tuff 6 was deposited after accumulation of the middle sedimentary member that overlies tuff 5 (35.1 ± 1.3 m.y.) and 2) tuff 6 overlies the Kneeling Nun (previously referred to as the basal Thurman tuff) in the southern Caballo Mountains from which a biotite concentrate yielded an age of 33.6 ± 1.5 m.y. (Burke and others, 1963). McDowell (1971) measured an almost identical age of 33.4 ± 1.0 m.y. on biotite from the Kneeling Nun Tuff at its type locality.

Upper sedimentary member (Tbsu)

Extensive exposures of conglomerate, tuffaceous sandstone, and mudstone are present throughout the eastern and northwestern parts of the map area. Lack of exposures over a 6-mi distance in the southwest part of the Good Sight Mountains is probably due to nondeposition in this area. This part of the Good Sight Mountains coincides with extensive Rubio Peak intrusive-extrusive complexes that probably provided high relief during the time of Bell Top deposition. The sedimentary beds dip 4-9 degrees west on the west flank of the Sierra de las Uvas, and to the northwest they dip 5-12 degrees east on the east flank of the Good Sight Mountains. Water-well drillers' logs show that the upper sedimentary member is continuous under the Uvas Valley. The upper sedimentary member conformably overlies tuff 6 to the east, near Nutt, and northeast of Butterfield windmill, and unconformably overlies Rubio Peak rocks throughout much of the Good Sight Mountains. Upper beds of the upper sedimentary member are interlayered with the lowest Uvas Basaltic Andesite flows in the central Good Sight Mountains, under part of the Uvas Valley, and in the Sierra de las Uvas, with 10-40 ft of sandstone and conglomeratic sandstone separating the Uvas flows. The upper beds also interfinger with Tenaga Canyon andesites in the vicinity of Nutt Mountain. Three miles northeast of Nutt Mountain the upper sedimentary member overlies Kneeling Nun Tuff and was intruded by Tenaga Canyon andesites. Thickness of the upper sedimentary member, not including the upper interbedded part, ranges from zero in the southwest Good Sight Mountains to about 100 ft near Good Sight Peak and 320 ft at the eastern edge of the map area.

Light-gray to reddish-brown tuffaceous sandstone and cobble conglomerate compose the upper sedimentary member. The rocks are poorly sorted volcanic arenites. Within the map area, the conglomerates contain mostly cobble-and-boulder-sized rounded clasts of Rubio Peak rocks and tuff 6, whereas to the east they are predominantly ash-flow and flow-banded rhyolite derived from the Cedar Hills area. In the northern Good Sight Mountains they also are characterized by abundant silicified boulders of unknown origin. These could possibly have come from the Lake Valley area to the northwest. To the east, the sandy beds contain angular plagioclase, quartz, sanidine, biotite and tuff grains. Westward the quartz, sanidine, and tuff content decreases, and plagioclase and andesite-latite content increases. Strata interbedded with the Uvas flows are predominantly calcite-cemented, fine to medium sandstone.

A section of 500 or more ft of tuffaceous sandstone and conglomerate (fig. 15) forming the lower slopes of Nutt Mountain is included in the upper sedimentary member. These beds are correlative and almost continuous (except for a narrow area of alluvial cover) with extensive outcrops of the member to the southeast. They overlie Rubio Peak and were intruded by Tenaga Canyon lavas; thus they have the same stratigraphic relations as the upper sedimentary member in nearby areas. The whole section was later intruded by Nutt Mountain rhyolite.

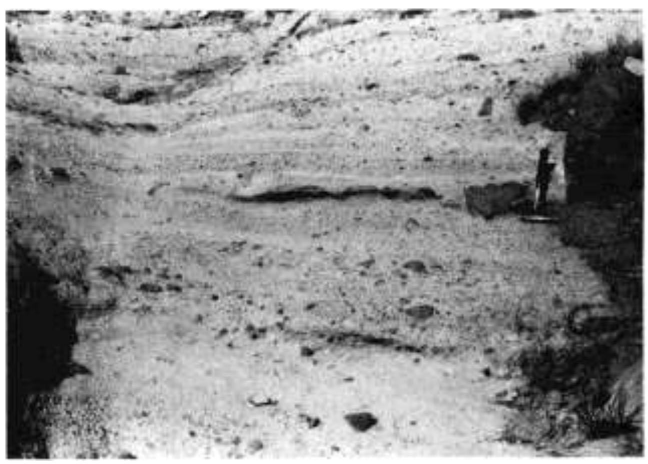

FIGURE 15—WELL-STRATIFIED PUMICEOUS, SANDY CONGLOMERATE EXPOSED IN LARGE GULLY ON NORTHEAST SIDE OF NUTT MOUNTAIN. Dark clasts are mostly from the Tenaga Canyon formation. Many of the beds possess low-angle crossbedding.

Kneeling Nun Tuff (Tkn)

Elston (1957) named the Kneeling Nun Tuff after the Kneeling Nun at Santa Rita, the type locality. Source of the Kneeling Nun Tuff has been quite conclusively established to have been the Emory cauldron (Elston and others, 1975) in the southern Black Range about 16 mi west-northwest of the map area (Kuellmer, 1954; Jicha, 1954; Elston, 1957; Ericksen and others, 1970). In the Dwyer and Lake Valley quadrangles, Elston (1957) and Jicha (1954) determined that the Kneeling Nun Tuff overlies the Sugarlump Formation (a sequence of ash-flow tuffs and interbedded volcaniclastic strata) and is overlain by the Mimbres Peak Formation (a highly variable unit of rhyolitic to andesitic rocks). Hedlund (1977) mapped the Kneeling Nun overlying Sugarlump, but he referred to the andesite-latite rocks overlying the Kneeling Nun as Pollack Quartz Latite of Jicha.

The Kneeling Nun crops out sporadically over a distance of about 3 mi north-northwest of Nutt Mountain with an exposed thickness of 10-100 ft. It was deposited on Rubio Peak rocks and later was intruded and overlain by the Tenaga Canyon formation. This point apparently marks the southeasternmost outcrop of the Kneeling Nun, but it may be present in the subsurface as far as the northern end of the Uvas Valley.

In the northern Good Sight Mountains, the Kneeling Nun is a single flow of crystal-vitric ash-flow tuff. It contains 29-40 percent phenocrysts of sanidine, quartz, and plagioclase in subequal amounts, biotite, and sparse amounts of hornblende, sphene, and apatite. Flattened pumice fragments are common and a few small rock fragments—mainly volcanic—are typically present. Most of the thin sections studied showed the glassy groundmass to be partly to almost completely divitrified with a spherulitic texture.

McDowell (1971) reported a potassium-argon age of 33.4 ± 1.0 m.y. for the Kneeling Nun Tuff at its type locality. Burke and others (1963) obtained a potassium-argon age of 33.6 ± 1.5 m.y. from the basal tuff in the Thurman Formation at Apache Valley, southeast of Caballo Reservoir. Clemons (1976b) tentatively identified the same basal tuff as Kneeling Nun on the basis of its petrography.

Tenaga Canyon formation (Ttc)

The name Tenaga Canyon formation (new name) is here proposed for the intrusive-extrusive complex of hornblende andesites and latites east and northeast of Nutt Mountain. These rocks intrude and overlie rocks as young as the upper sedimentary member of the Bell Top Formation and in turn were intruded (fig. 16) and overlain by the Uvas Basaltic Andesite. The type locality is Tenaga Canyon, 2 mi northeast of Nutt Mountain. Total outcrop area is about 11 mil.

The predominant Tenaga Canyon rocks are medium- to dark-gray, dense, fine-crystalline rocks ranging from nonporphyritic to slightly porphyritic andesite-latite. In the field Tenaga Canyon rocks closely resemble the

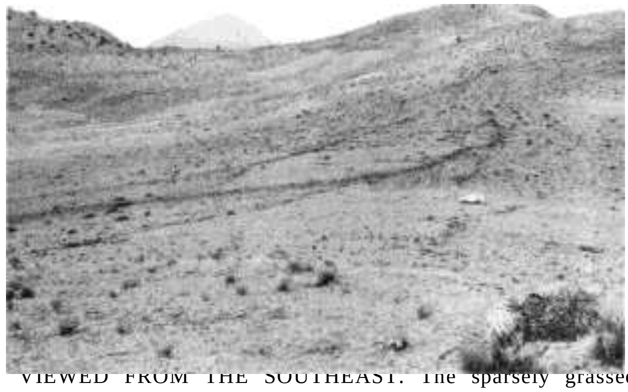

FIGURE 16—NUTT MOUNTAIN (IN BACKGROUND) VIEWED FROM THE SOUTHEAST. The sparsely grassed slopes are Tenaga Canyon andesite. The dark streaks crossing photo from middle left toward upper right are Uvas Basaltic Andesite dikes. Another small dike curves behind white vehicle.

Rubio Peak intrusive-extrusive complexes. They can be distinguished only by following continuous outcrops from the places where Tenaga Canyon intrudes and overlies Kneeling Nun Tuff or the upper sedimentary member of the Bell Top Formation. The Uvas Basaltic Andesite is distinctly darker colored (dark gray to black) and the dense dike and vent rocks can be traced into the typical vesicular to scoriaceous Uvas flows.

In thin section the porphyritic rocks contain about 1-10 percent plagioclase (An_{28-38}) phenocrysts and 2-5 percent hornblende phenocrysts, up to 2 mm long, in a hyalopilitic-pilotaxitic matrix. The plagioclase is progressively and oscillatory zoned. The hornblende is intensely oxidized and typically its earlier presence is indicated only by hematite-magnetite ghosts outlining the euhedral crystals. Hypersthene is present in minor amounts, and a trace of augite can be found in some thin sections. The matrix consists of tiny (.005-.05 mm) plagioclase microlites and a cloudy, cryptocrystalline to glassy material. The nonporphyritic rocks are composed of pilotaxitic-hyalopilitic plagioclase laths averaging about 0.1 mm long and 0.01-0.03 mm wide.

The Tenaga Canyon formation is correlative with the rocks Hedlund (1977) mapped as Pollack Quartz Latite in the southern Sibley Mountains, north of Lake Valley. It may be correlative with the Bear Springs Basalt (Elston, 1957) or part of the Mimbres Peak Formation (Elston, 1957) in the southern Black Range and Cooke's Range. Because of the lack of chemical analyses, ages, and detailed petrography of all these units, none of the above names were extended to the Good Sight Mountains. I do not agree with Hedlund's naming the rocks in the Sibley Mountains Pollack, for they differ significantly from Jicha's (1954) description at the type locality. The rocks overlying the Kneeling Nun Tuff in the Sibley Mountains are probably correlative with the Bear Springs Basalt or part of the Mimbres Peak Formation.

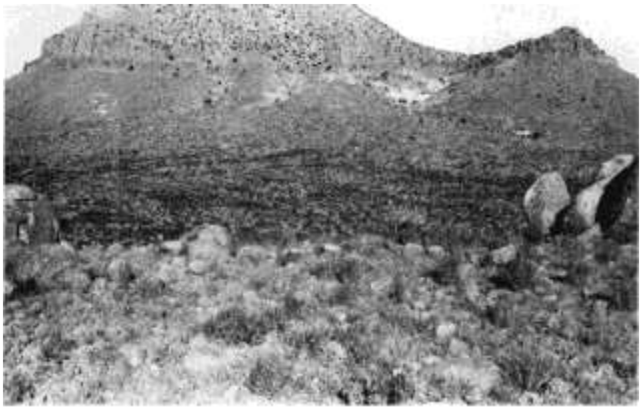

FIGURE 17—VIEW OF NUTT MOUNTAIN (ELEV. 5,940 FT) FROM TOP OF RHYOLITE DIKE ABOUT 1 MI TO THE EAST. Flow-banded rhyolite intrusion is located at left (southwest) side of Nutt Mountain and short flow to right (northeast) possesses crude columnar jointing. Close-up view of sediments in white area under flow is shown in figs. 15 and 18.

Nutt Mountain rhyolite (Tnr)

The name Nutt Mountain rhyolite (new name) is here proposed for the flow-banded rhyolite at Nutt Mountain. It is a local formation, found only within 1 mi of Nutt Mountain. The main body is a plug-like intrusion about 0.5 mi in diameter; a short flow extends about 0.1 mi northeastward from the vent (fig. 17). The only other outcrops are a dike 0.7 mi long and 200 ft wide about 1 mi northeast of Nutt Mountain, and a small exposure in the lower northwest slopes of the mountain. The rhyolite intrudes the Tenaga Canyon formation and upper sedimentary member of the Bell Top Formation. The contact is poorly exposed except in a large gully on the northeast side of Nutt Mountain where perlite breccia (fig. 18) intrudes or is angularly unconformable on the upper sedimentary member.

The rhyolite is a pale-red rock with prominent flow-banding and large, elongate vesicles in the outer parts, grading into a massive, mottled-appearing rock with conspicuous, irregularly-shaped, pinkish-gray areas 1-20 mm across. Flow folds and autobrecciated zones are common. Almost equal amounts of euhedral quartz, sanidine, and oligoclase phenocrysts with traces of biotite and sphene compose approximately 12 percent of the rock. They appear in a cryptocrystalline to fine spheruli-tic groundmass.

The age of the Nutt Mountain rhyolite is uncertain. It intrudes the Tenaga Canyon formation, which overlies Kneeling Nun Tuff (33.4 m.y.). If the Tenaga Canyon is the same age as the Bear Springs Basalt (26.6 to 29.8 m.y.), this relationship would provide a maximum age for the Nutt Mountain rhyolite. The Tenaga Canyon is also intruded by the Uvas Basaltic Andesite (26 m.y.). The Nutt Mountain rhyolite closely resembles and may be correlative with the 26.6-m.y.-old Swartz Rhyolite

FIGURE 18—HAMMER IS ON CONTACT OF CROSSBEDDED PUMICEOUS SEDIMENTS BELOW PERLITE BRECCIA ON NORTHEAST SIDE OF NUTT MOUNTAIN. Flow-banded rhyolite is barely visible in extreme upper right corner of photo.

(Elston, 1957, Elston and others, 1973) or the 32.0-m.y.-old Mimbres Peak rhyolite (Elston and others, 1973).

Uvas Basaltic Andesite (Tu)

The Uvas Basaltic Andesite was defined by Kottlowski (1953b) for exposures in the Sierra de las Uvas. Clemons and Seager (1973) assigned a type locality and described a type section in the northeastern part of the Sierra de las Uvas. Subsequent studies (Seager and others, 1975, Seager and Hawley, 1973; Clemons, 1976a, 1976b, 1977) indicate that there were Uvas Basaltic Andesite vents in the Point of Rocks and Sleeping Lady Hills as well as several in the Sierra de las Uvas. Another vent has been mapped 3.5 mi southeast of Nutt Mountain during this study.

Flows of Uvas Basaltic Andesite cap the west-dipping cuestas and buttes in the Sierra de las Uvas along the eastern side of the map. The east-dipping cuestas, from 6 mi southeast of Good Sight Peak (fig. 19) northward to Nutt Mountain, are also capped by Uvas flows. NM-26 crosses some of these flows 2 mi east of Nutt. The flows are more or less continuous under the Uvas Valley, conformably overlying the Bell Top Formation and are unconformably overlain by Santa Fe Group strata and Quaternary pediment gravels and bolson fill. There are

FIGURE 19—BLOCKY, DENSE ROCK IN FOREGROUND IS PART OF A RUBIO PEAK INTRUSIVE-EXTRUSIVE COMPLEX 2 MI EAST OF BROWNFIELD RANCH. Good Sight Peak (elev. 5,602 ft) on skyline 4 mi to the north is capped by east-dipping Uvas Basaltic Andesite flows.

no exposures of Uvas Basaltic Andesite in the southern Good Sight Mountains. Its absence around the southern end of the north-plunging Uvas Valley syncline may be due to either erosion or nondeposition. Thickness of the Uvas ranges up to 300 ft and varies considerably depending upon the number of flows present in the local sections. Drillers' records indicate that one well may penetrate only one Uvas flow and another well less than a mile away, may penetrate six flows.

Flows forming the Uvas are mainly basaltic andesite (hawaiite). They are all dark-gray to black microvesicular or vesicular rocks, ranging to scoriaceous in the upper part of each flow. Microphenocrysts of oxyhornblende up to 1.5 mm long are set in an intergranular felted matrix of andesine laths (averaging 0.3 mm), augite, and magnetite grains. Olivine microphenocrysts occur in a few flows.

The Uvas flows on the east side of the map area can be traced continuously to those described by Clemons and Seager (1973) and probably came down slopes and valleys from the vent north of Magdalena Peak. The Uvas in the northern Good Sight Mountains flowed from a vent located at the corner of secs. 6 and 7, T. 20 S., R. 5 W., and secs. 1 and 12, T. 20 S., R. 6 W. Uvas flows in the vicinity of Good Sight Peak may have come from either source.

Two potassium-argon whole-rock determinations of 25.9 ± 1.5 m.y. (Clemons and Seager, 1973) and 26.1 ± 1.4 m.y. (Clemons, 1976a) provide a late Oligocene-early Miocene age for the Uvas Basaltic Andesite. An additional whole-rock potassium-argon age of 27.4 ± 1.2 m.y. (Clemons, 1976a) was obtained from a sample of a large intrusion, believed to be Uvas, 7 mi east-northeast of the small Uvas intrusion on the southeast side of the map area, 3 mi east of Lazy E Ranch.

Santa Fe Group

The extent and general composition of the Santa Fe Group in south-central New Mexico was described by Hawley and others (1969). Some of its regional relationships were discussed by Hawley and others (1976). The Santa Fe is 3,625 ft thick and includes four formations in the Rincon Hills area (Seager and Hawley, 1973), about 10 mi east of the map area of this report. In ascending order, the formations are: unnamed transitional unit, Hayner Ranch Formation, Rincon Valley Formation, and Camp Rice Formation. Only the Camp Rice Formation crops out in the Good Sight Mountains and Uvas Valley area, but the Rincon Valley Formation is present in the subsurface of the Uvas Valley.

Rincon Valley Formation (Trv)

The Rincon Valley Formation was named by Seager and others (1971). The type section was actually measured and described earlier by Hawley and others (1969). It is considered to be late Micoene to Pliocene in age on the basis of the interbedded 9-m.y.-old Selden Basalt (Gile and others, 1970).

The closest outcrops of the Rincon Valley Formation are at an elevation of 4,380 ft, 2 mi east of the northeasternmost corner of the map area (figs. 20 and 21). The top of the formation descends to an elevation of 4,260 ft 4 mi north of NM-26 where the highway leaves the eastern side of the map area. The driller's log for a water well near the western side of sec. 31, T. 19 S., R. 4 W., indicates that what is interpreted as "basin-floor facies" of the Rincon Valley Formation (red clay) is 810 ft thick with its top at an elevation of about 4,325 ft. It is underlain by Uvas Basaltic Andesite and overlain by Camp Rice "sand and clay." Southwestward the basin-floor facies probably grades into a basin-margin facies that may be present under much of the Uvas Valley.

Camp Rice Formation (Qcr)

The Camp Rice Formation (Strain, 1966, 1969), youngest formation in the Santa Fe Group, crops out almost continuously around the southern margin of the Uvas Valley and north of the Good Sight Mountains. Except for a narrow band of Rincon Valley Formation, which parallels the Rio Grande floodplain, the Camp Rice is the oldest unit exposed in the Arroyo Cuervo quadrangle (which is the area occupied by the explanation on the geologic map). The work of Hawley and others (1969), Seager and others (1971), and Seager and Hawley (1973) has shown that the Camp Rice is late Pliocene to middle Pleistocene in age and represents the culmination of basin filling in south-central New Mexico prior to incision of the present Rio Grande valley system. Three units were used for mapping purposes during the present study.

Basin floor facies (Qcrf)

The basin-floor facies (Seager and Hawley, 1973) consists chiefly of channel and floodplain deposits of an ancestral Rio Grande. Light-gray to brown arkosic sand, and gravelly sand (locally indurated), with minor interbedded sandy clay compose the bulk of these deposits. Individual beds are moderately sorted and range from fine to coarse grained. Granules and pebbles in the gravelly sands are subrounded to rounded and of mixed lithology. Intermediate volcanic rocks are dominant with significant amounts of granite, chert, and quartzite, and traces of obsidian.

The only exposure of this unit is just south of NM-26 at the eastern edge of the map. However, continuous exposures are abundant to the north in the Arroyo Cuervo (figs. 20 and 21) and Hatch quadrangles. A measured section of 334 ft along Arroyo Cuervo is described in appendix 1.

Piedmont-slope facies (Qcrp)

The piedmont-slope facies (Seager and Hawley, 1973) is composed chiefly of alluvial-fan and coalescent-fan deposits. The facies also includes thin alluvial and colluvial veneers on erosion surfaces (in part, rock pediments) cut on Uvas Basaltic Andesite and older formations along the west flank of the Sierra de las Uvas and eastern slopes of the Good Sight Mountains. This unit is typically very gravelly. The lower beds are poorly cemented and the upper beds are usually well cemented with caliche, with loose lag gravel on top. The mean-sized clasts are in the pebble-to-small-cobble range, but boulders up to several feet across are common locally.

Composition of the gravel fraction invariably reflects the lithology of adjacent uplands. On the west flank of the Sierra de las Uvas the lithology is dominated by Uvas Basaltic Andesite, with minor ash-flow tuff and sandstone clasts; on the eastern slopes of the Good Sight Mountains andesite and latite are dominant, with an influx of flow-banded rhyolite noticeable east of Nutt Mountain. Farther north, ash-flow tuff (especially Kneeling Nun) and other rocks exposed in the southern Black Range and Lake Valley area are represented in the gravels along with andesite and latite.

Obsidian pebbles are quite common in surface lag gravel in sec. 1, T. 19 S., R. 5 W., at the northern end of the Good Sight Mountains. These pebbles are true obsidian and not detritus from vitrophyres like the one that crops out in Tierra Blanca Canyon. Farther south the presence of obsidian is used as evidence for deposition by the Rio Grande (hence basin-floor facies, Qcrf). The source of this obsidian is unknown, but the area seems too far west for ancestral Rio Grande deposition. However, the Rio Grande may have meandered this far west at one time, or may even have flowed west of the northern Good Sight Mountains fault block. Future detailed mapping of Quaternary strata to the north or discovery of an obsidian source in the southern Black Range may shed light on this problem.

Calcium carbonate is the major cementing agent of the surficial beds of the piedmont facies. Well drillers commonly reported 20-30 ft of caliche between the northwest Sierra de las Uvas and the Uvas Valley. Two wells reported between 50 and 60 ft of "caliche" in sec. 5, T. 21 S., R. 5 W., near the southern end of extinct Lake Goodsight.

Post-Camp Rice basalt flows emplaced about 0.2 m.y. ago southwest of Las Cruces support a general middle Pleistocene age for the piedmont-slope facies (Hawley and others, 1969; Hoffer, 1971; Lifshitz-Roffman, 1971). The upper surface of the piedmont-slope facies unit forms the Jornada I surface of Gile and Hawley (1968) and the Palomas surface of Kelley and Silver (1952).

The third Camp Rice mapping unit, Qcr, designates undifferentiated piedmont toe-slope deposits in general, but may include some interfingering fluvial facies.

FIGURE 20—BROWNISH CAMP RICE CONGLOMERATIC SANDS (QCRF) UNDERLAIN BY DARK RED-BROWN SILTY MUDSTONE AND CLAY SHALE, north bank of Jaralosa Arroyo 2 mi east of northeast corner of map area.

FIGURE 21—CHANNEL FILL OF CAMP RICE CONGLOMERATE (QCRF) CUT INTO TOP OF RINCON VALLEY BASIN-FLOOR DEPOSITS. Exposure is on south side of Jaralosa Arroyo 2 mi east of northeast corner of map area.

Quaternary alluvium and lacustrine deposits

Post-Santa Fe valley deposits have been described in detail by Hawley (1965), Metcalf (1967), and Hawley and Kottlowski (1969). Evolution of the river and arroyo-valley system was characterized by several periods of major valley cutting interspersed with periods of partial backfilling. The informal rock-stratigraphic terminology used in this study was initially developed by Seager and Hawley (1973). It has been used also in south-central New Mexico by Seager (1975a), Seager and others (1975, 1976), and Clemons (1976a, 1977). Two major alluvial sequences are utilized in this study: one associated with drainage into the Rio Grande (Qvo and Qvy) and the other with piedmont-slope drainage into closed basins (Qpo and Qpy). Textures and lithology of both units are essentially the same.

Older valley and piedmont-slope alluvium (Qvo and Qpo)

These deposits are similar in composition to the Camp Rice Formation piedmont facies because they strikingly reflect the lithology of local source areas. They include arroyo terrace and fan deposits and thin (less than 10 ft) veneers on erosion surfaces. Rarely does the thickness of these units exceed 25 ft. Sporadic zones of soil-carbonate (caliche) cemented horizons a few inches thick occur in the thicker veneers.

Where nearby exposures indicate the rock unit beneath the alluvium, both lithologies are shown on the map by a combined symbol. For example the extensive area in the northwestern part of the geologic map is mapped as Qvo/Qcr. The piedmont-slope deposits (Qpo) intertongue with and grade into finer-grained basin-floor sediments (Qbf) in areas where piedmont-slope and basin-floor surfaces merge in the Uvas Valley and west of the southern Good Sight Mountains in the Mimbres Basin (fig. 3).

Younger valley and piedmont-slope alluvium (Qvy and Qpy)

These units include deposits associated with late Wisconsinan (less than 25,000 years B.P.) and Holocene episodes of valley entrenchment and partial backfilling (Seager and others, 1975). Arroyo channel, terrace, and fan deposits of tributaries to the Rio Grande are mapped as Qvy. Similar deposits on piedmont slopes grading to the closed Uvas Valley and Mimbres Basin are mapped as Qpy. Maximum thickness may be 50 ft in a few fan deposits, but the unit thins quickly upstream and is generally less than 15 ft thick throughout the map area. Zones of soil-carbonate accumulation are weak or absent in these deposits.

An undifferentiated piedmont unit (Qpa) is used in areas where Qpo and Qpy deposits did not warrant mapping separately.

Colluvial and alluvial deposits (Qca) have been mapped in areas where they form a relatively continuous cover on older units. These deposits are generally less than 10 ft thick and occur on steeper slopes, but some undifferentiated valley-floor and piedmont-slope alluvium may be included. As expected, the deposits reflect the lithology of nearby higher slopes and ledges. Most of the mapping unit is an age equivalent of older and younger valley and piedmont-slope alluvium. Locally, it may correlate with the younger piedmont-slope facies of the Camp Rice Formation.

Basin-floor facies (Qbf and Q1)

Basin-floor sediments occupy a rather extensive area in the southwest corner of the mapped area at the terminus of Macho Creek. They include loamy to clayey alluvium in a basin area essentially unaffected by arroyo incision. The deposits are typically void of gravel, but sporadic gravelly lenses represent times of more intense flooding.

Another large area of basin-floor sediments is in the northern Uvas Valley. This elongate area trends northeast for about 11 mi and ranges in width from 1 to 3 mi. Its extent approximately outlines Lake Goodsight of late Pleistocene age (Hawley, 1965). A prominent wave-built bar (Qbfb) and many smaller relict lake-shore features at elevations between 4,480 and 4,500 ft indicate that the central Uvas Valley depression was once occupied by a permanent lake with a 10 to 15 mil surface area. At present only small playa-lake basins occupy the lower parts of the depression (Hawley and others, 1975). Thin layers of younger basin-floor sediments overlie lacustrine sediments. The latter range from greenish, ostracode-bearing clays (up to 15 ft thick) to thin sand and gravel deposits of beaches and nearshore bars.

Ephemeral-lake sediments (Q1) consist of clayey material in small playa-lake depressions. These deposits are generally less than 10 ft thick. The playas in the Uvas Valley are 80-120 ft above the water table and seldom contain standing water.

Windblown sand (Qs)

Eolian sand covers large areas on the northeastern sides of the closed basins (Mimbres and Uvas Valley) reflecting deflation of the basins and deposition by the prevailing southwesterly winds. The dunes are generally less than 10 ft high, but longitudinal dunes 20 ft high are present northeast of the ancestral Lake Goodsight beach bar. Most of the dunes are more or less stabilized by mesquite, creosote, yucca, and other desert vegetation. Locally the sand sheet is underlain by a thick soil-carbonate zone. Where nearby exposures permit, a double map symbol is used to indicate the unit underlying the eolian sand, such as Qs/Qbf.

Structure

The north-plunging symmetrical syncline that forms the Uvas Valley has been referred to as the Uvas Valley syncline (Hawley and Kottlowski, 1965; Hawley and others, 1975) and the Good Sight Valley syncline (Seager, 1973). The Good Sight Mountains, which form the western flank, curve southeast around the southern end of the syncline and connect with the southwest spur of the Sierra de las Uvas, which forms the eastern flank. North of the map area, the synclinal axis curves slightly northeast, tending to wrap around the northwestern sides of the Sierra de las Uvas dome. The axis is offset 1-3 mi east of the topographic valley center because larger quantities of debris have been contributed from the eastern side during the filling of the valley. Seager (1973) attributed the origin of the Uvas Valley syncline to uplift of the Sierra de las Uvas within the Good Sight-Cedar Hills volcano-tectonic depression about 20-26 m.y. ago. Structural relief between the top of the dome and axis of the Uvas Valley syncline is about 2,600 ft.

The Good Sight Mountains contain numerous dikes, plugs, stocks, and massive intrusive-extrusive complexes. These are clustered in a north-trending zone about 30 mi in length and 4 mi wide. In an area of 120 mil no less than 45 basaltic andesite, andesite, latite, and rhyolite protrusions occur. This area is here named the Good Sight Mountains vent zone. There are no large circular eruptive centers such as cinder cones or strata volcanoes preserved, and probably none ever existed. The prevailing easterly and northerly dips in the breccias suggest that the area was on the east flank of a mountain range with many coalescing vents and conduits.

The 38-m.y. age of the Rubio Peak andesite suggests that the Good Sight Mountains vent zone was a contemporary of the early activity in the Cedar Hills vent zone. Bell Top Formation ash-flow tuffs, derived from the Cedar Hills' vents, have yielded ages of about 35-39 m.y. The younger tuffs and interbedded sediments pinch out toward the Good Sight Mountains and indicate that the mountains were a high area at that time. The younger Bell Top sediments were also in part derived from the ancestral Good Sight Mountains.

A high-angle normal fault has been inferred (Seager, 1975b; Ramberg and others, 1978) along the western side of the Good Sight Mountains, but it is not exposed at the surface. A gravimetric survey of three profiles into the Mimbres Basin from the Good Sight Mountains showed no anomaly as evidence for significant displacement. If the Good Sight block has been tilted eastward along such a fault, removal of the 5-10 degrees of tilt on the capping Uvas flows will also rotate the Rubio Peak breccia beds to horizontal and many to west-dipping attitudes. There are no possible sources of this material to the east, so another tilting episode (in the reverse direction) would be required between the depositional times of the Rubio Peak and Uvas Basaltic Andesite. Uplift without tilting on the inferred fault would eliminate the problem.

A northeast-trending fault is exposed at the northern end of the Good Sight Mountains in the southwest corner of sec. 36, T. 18 S., R. 6 W. Camp Rice beds on the hanging wall block northwest of the fault are in contact with Rubio Peak andesites on the southeast side of the fault. Exact displacement is unknown but about 4,000 ft of vertical offset is estimated, assuming a constant southeasterly dip of about 8 degrees on the Kneeling Nun Tuff between its exposures in the southern Sibley Mountains and the northern Good Sight Mountains. This fault (or fault zone) shows up on the Bouguer gravity anomaly map of Ramberg and others (1978). It is one of a series of en echelon faults that extends from southeast of Deming to the Caballo Mountains, crossing the Florida Basin approximately parallel to NM-26 between the southern tip of the Cooke's Range and the Good Sight Mountains.

Ground water

The Quaternary gravel and sand deposits that form the bolson fill constitute a major producing aquifer in the study area. The upper sedimentary member of the Bell Top Formation and scoriaceous zones in the Uvas Basaltic Andesite are additional aquifers bringing water from their outcrops in the Sierra de las Uvas westward under the Uvas Valley. Tuff 6, which underlies the upper sedimentary member, is relatively impermeable. Tuff 6 cannot be identified in the drillers' logs; it was apparently recorded as "sand and clay" because its cuttings would closely resemble the tuffaceous sediments. Many of the irrigation, stock, and domestic wells in the Uvas Valley are completed in the upper sedimentary member. Additional supplies may be in the middle sedimentary member, below tuff 6, in the southeastern part of the Uvas Valley.

Depths to the water table (fig. 22) in the Uvas Valley section of the map area range from about 65 to 120 ft below the central valley floor (table 1). Wells up the pediment slope toward the eastern side of the valley record depths up to 397 ft to the water table (Hudson, 1976). Long-range records show that the water table in the central Uvas Valley dropped about 40 ft between 1962 and 1978 (U.S. Geological Survey, 1976; unpublished data at State Engineer's Office, Deming, 1978). An unpublished water-table map by R. L. Borton of the

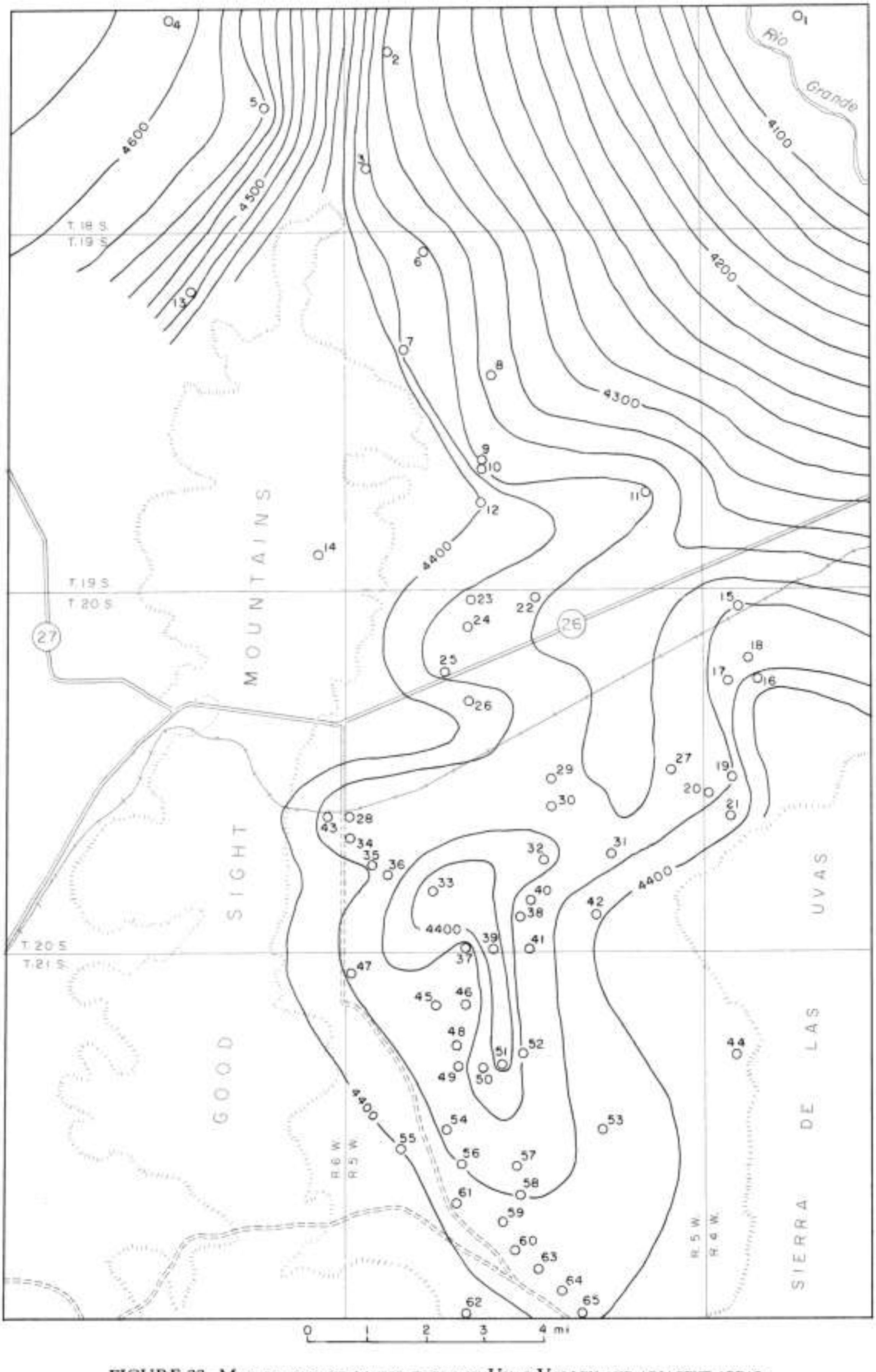

FIGURE 22—Map of ground-water table in Uvas Valley and adjacent areas.

TABLE 1—RECORDS OF WELLS IN THE NUTT-HOCKETT UNDERGROUND WATER BASIN; all the townships in table 1 are south of the New Mexico base line, and all ranges are west of the principal meridian. Data from Busch and Hudson (1969), Hudson (1975, 1976), and unpublished State Engineer (Deming) records for 1977, 1978.

Well	Location	Approx. elev.	Depth of water level below land surface (ft)				
			1968	1974	1976	1977	1978
1	18.4.17.211	4093			9		
2	18.5.18.434	4584		254	255	248	248
3	18.5.30.343	4526		168	166	162	162
4	18.6.15.133	4810		207		205	205
5	18.6.23.433	4700				130	130
6	19.5.05.144	4585		216	213	212	215
7	19.5.07.444	4650		268	269	269	273
8	19.5.16.144	4536		107	106	107	110
9	19.5.21.341	4567		192	198	205	214
10	19.5.21.343	4563		189	196	203	211
11	19.5.25.131	4523		151	150	160	158
12	19.5.28.320	4545		138	135		
13	19.6.03.344	4750		264	266	265	263
14	19.6.36.311	4780		341	341	342	
15	20.4.06.212	4513			132	132	
16	20.4.07.244	4580					161
17	20.4.07.144	4552		154	155	154	155
18	20.4.07.221	4555				168	173
19	20.4.19.122	4577		198	199	193	201
20	20.4.19.131	4558		171	175	175	181
21	20.4.19.324	4587		186	189	189	195
22	20.5.03.112	4505		126	129	141	143
23	20.5.04.110	4512		131	137	140	142
24	20.5.04.311	4500					134
25	20.5.08.231	4490		99	103	106	115
26	20.5.09.331	4465		77		67	67
27	20.5.13.344	4525		148	151	157	162
28	20.5.19.313	4520		136	141	142	152
29	20.5.22.122	4470		90	95		
30	20.5.22.322	4485		106	109	118	120
31	20.5.26.142	4530		159	158		
32	20.5.27.143	4497		124	96	105	107
33	20.5.29.344	4477	63		56	60	65
34	20.5.30.111	4505		119	125	125	134
35	20.5.30.322	4485	64	91	96		
36	20.5.30.414	4471				103	110
37	20.5.32.444	4505	94	124	125	130	
38	20.5.33.244	4525		143	147	147	157
39	20.5.33.344	4518		108	108	106	107
40	20.5.34.111	4520	129	142	142		
41	20.5.34.333	4544		163	167	169	172
42	20.5.35.132	4550	130	142	146		
43	20.6.24.414	4530		142	146	150	159
44	21.4.07.433	4810		396	397	398	
45	21.5.05.344	4508	97	122	126	131	138
46	21.5.05.444	4526	110	137	141	145	152
47	21.5.06.133	4495	76	103	109	112	118
48	21.5.08.422	4520		143	147	152	156
49	21.5.08.444	4532	114			153	155
50	21.5.09.344	4558		162	164	169	175
51	21.5.09.434	4570		155	156	162	167
52	21.5.09.442	4570		185	186	192	195
53	21.5.14.344	4622		226	226	228	232
54	21.5.17.434	4520				136	142
55	21.5.19.223	4530	105	124	125	125	129
56	21.5.20.422	4528	104		133	144	148
57	21.5.21.421	4545				163	166
58	21.5.21.444	4549		156	159	165	169
59	21.5.28.231	4538				152	
60	21.5.28.441	4547				159	157
61	21.5.29.222	4536		145	145	151	153
62	21.5.32.444	4615					134
63	21.5.34.114	4547			150	156	159
64	21.5.34.410	4553		151	164	160	161
65	21.5.34.444	4560	138	155	159	162	163
66	21.6.27.433	4736				122	124

State Engineer's Office (Santa Fe) shows that in 1972 the water table was between 4,385 and 4,390 ft elevation along the northeastern end of the Uvas Valley. Fig. 22 shows that present elevations of the water table there are about 4,360 ft. The lowering of the water table in recent years is probably a result of increased discharge for irrigation. Wells used primarily for stock tanks, away from irrigation wells, show little change in water levels.

Examination of the water levels reveals several unusual characteristics. The mound in the water table under the southwest Uvas Valley and the inconsistent lowering of levels in nearby wells are probably a result of partial artesian recharge through the sandstones and conglomerates interbedded with the Uvas flows and the Bell Top Formation below the Uvas Basaltic Andesite. The permeable beds may be recharged in the Sierra de las Uvas and the water is then confined below ash-flow tuffs and Uvas flows. Deep wells in the Uvas Valley tap these additional lower aquifers. About 800 ft of Rincon Valley Formation red clay and mudstone also acts as an aquiclude under the northern end of the Uvas Valley. There are numerous springs at the contact of the Rincon Valley Formation and overlying Camp Rice Formation in the arroyos of the Arroyo Cuervo quadrangle.

Trauger and Doty (1965) presented a good review of the relations of ground water to the economy and geology in southwestern New Mexico. Seager and Hawley (1973), Seager and others (1975), and King and others (1971) have described the occurrence of ground water in relation to the local geologic rock units in areas to the east and south.

The location of the wells in table 1 are identified by the location-number system used by the U.S. Geological Survey and New Mexico State Engineer. The number is a description of the geographic location of the well, based upon the common U.S. Land Survey subdivision of the nearest 10-acre tract. The location number consists of a series of digits corresponding to the township, range, section, and tract within a section, in that order, as illustrated in fig. 23. If a well has not been located closely enough to be placed within a particular tract, a zero is used for that part of the location number. All the townships in table 1 are south of the New Mexico base line, and all ranges are west of the principal meridian.

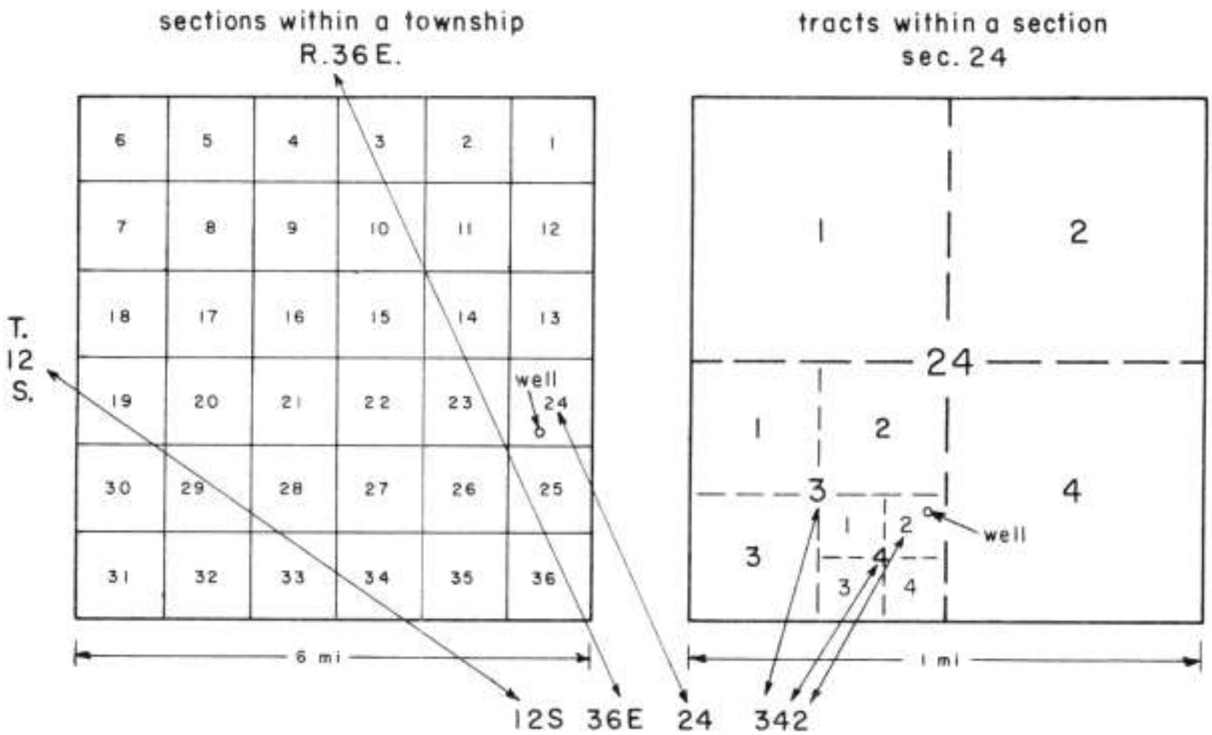

FIGURE 23—SYSTEM OF NUMBERING WELL LOCATIONS

Nonmetallic resources

Clay

Small tonnages of bentonite were mined 1.4 mi north of the map area (at the Sierra-Doña Ana County line) during the 1930's and the early 1940's. The deposit consists of an 8-ft bed near the top of the Camp Rice Formation (see Arroyo Cuervo section, appendix 1). The montmorillonite clay bed crops out for a couple of miles and probably continues in the subsurface for some distance under the northern Uvas Valley. According to Patterson and Holmes (1965), a plant built in Hatch processed the clay for drilling mud. Each ton of this bentonite made 60 barrels of 15-centipoise viscosity drilling mud (Reynolds, 1952). Nutting (1943) reported that a sample of the bentonite had excellent oil-bleaching properties after acid treatment.

The fine-grained sediments deposited in Lake Goodsight near the lowest part of the Uvas Valley contain much similar clay, but apparently they have not been analyzed. They now underlie areas being farmed and no estimate of their volume or quality was made, but it appears that they contain much intermixed silt and sand.

Perlite

Perlite is a water-rich siliceous volcanic glass that can be expanded under high heat to form artificial pumice for use as a lightweight aggregate. A perlitic phase of the Nutt Mountain rhyolite intrusion represents a minor occurrence of doubtful commercial value. It apparently only occurs as a zone about 20 ft wide along the eastern margin, where it is underlain by pumiceous sediments and overlain by flow-banded, spherulitic rhyolite. The upper part of the perlite breccia is locally contaminated by spherulitic and lithoidal bands.

Sand, gravel, caliche

Gravels in the Camp Rice and younger alluvial units are used locally for highway construction material. Information on engineering properties of aggregate resources and soils in the southern part of the map area is included in a New Mexico Highway Department report (1962). Sand and gravel deposits of south-central New Mexico are so widespread and abundant that the occurrences in the map area do not warrant detailed analysis. However, these deposits should be inventoried for local needs as population and industry growth continue. Ordinary sand for construction, paving, plaster, and similar purposes can be produced from the fluvial facies (Qcrf) of the Camp Rice Formation as well as from the gravel deposits (Qcrp and Qpo). Eolian sand from the northeast sides of the Mimbres Basin and Uvas Valley might be used for similar purposes because it is relatively clay free and well sorted. Small amounts of caliche from the Palomas Basin floor have been used locally for building ranch roads. Huge reserves remain around the Uvas Valley if the need arises.

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Appendix 1—Measured Sections

Arroyo Cuervo section—Section begins 0.2 mi south of La Capilla de Don Silverio in sec. 6, T. 19 S., R. 4 W. and continues southward up Arroyo Cuervo to the NW¼ sec. 25, T. 19 S., R. 5 W. Top of section is 0.3 mi north of map area boundary with Arroyo Cuervo quadrangle. Color code (in parentheses) from soil color charts by Munsell Color Co., Inc.

Unit	Description	Thickness (ft)
	Camp Rice Formation (total thickness)	334
17	Top of section at surface of caliche caprock forming Palomas Basin floor. This soil petrocalcic zone thickens to the east and pinches out to the west. A veneer of late Quaternary eolian sand and alluvium covers Camp Rice strata in the Uvas Valley	1
16	Interbedded arkosic sandstone and clay shale; sandstone near base grayish-orange-pink (5YR7/2), well-sorted, fine-grained, slightly calcitic, friable, laminated in 3- to 24-inch beds; sandstone near top coarse-grained to very coarse grained, calcitic, festoon crossbedded in 8- to 30-inch beds; interbedded pale red (5R6/2) clay shale near base grading upward to silty mudstone with irregular nodular carbonate accumulations	52
15	Clay, pale-red (10R6/2) to dark-reddish-brown (10R3/4) with few zones of waxy grayish-green (5G5/2); montmorillonite (bentonite)	8
14	Mudstone, pale-red (10R6/2), calcitic, 4- to 18-inch beds; interbedded arkosic sandstone, pinkish-gray (5YR8/1), fine-grained, calcitic, 6- to 18-inch beds	23
13	Sandstone, pinkish-gray (5YR8/1); very fine grained, calcitic, 1- to 2-ft beds; interbedded with 2- to 4-inch beds of pale-red (10R6/2) mudstone; sand fraction and size increasing upward in unit so top is festoon crossbedded, medium-grained arkosic sandstone	25
12	Interbedded sandstone and clay; sandstone near base is pale-red (10R6/2); fine-grained, calcitic but poorly cemented, 3- to 18-inch beds; gradational upwards to pale-yellowish-brown (10YR6/2), festoon crossbedded, medium- to coarse-grained sand and calcitic sandstone; pale-red (5R6/2) clay shale interbeds 1- to 3-inches	44
11	Sandstone, moderate-yellowish-brown (10YR5/4); very fine grained, calcitic; capped by well-cemented, calcitic, 3- to 6-inch, grayish-pink (5R8/2) fine-grained sandstone	3
10	Mudstone, pale-reddish-brown (10R5/4); interbedded with fine-grained, sandy mudstone, pale-red (10R6/2); laminated crossbedding in 1- to 4-ft beds; irregular nodular layers of carbonate accumulations above 1- to 3-inch-thick red clay shale partings	21
9	Interbedded conglomeratic sandstone, siltstone, mudstone; sandstone, grayish-orange (10YR7/4), poorly sorted, medium-grained, calcitic, 4- to 6-inch beds; siltstone, yellowish-gray (5Y7/2), slightly pebbly; mudstone, pale-reddish-brown (10R5/4), few gypsiferous zones; 1- to 2-ft lenses of crossbedded, calcitic, coarse-grained, arkosic sandstone near top of unit contain rounded pebbles of mixed volcanic rocks, quartz, chert, and granite	19
8	Shale, grayish-orange-pink (5YR7/2); silty, 1- to 3-inch selenite crystals lie on surface; contains sparse rounded pebbles and granules of same composition as unit 9	4
7	Siltstone, moderate-reddish-brown (10R4/6); coarse, sandy, decreasing upward with increase of clay; slightly calcitic	28
6	Pebble conglomerate, pale-yellowish-brown (10YR6/2); muddy, crossbedded, calcitic; subangular to subrounded mixed volcanic rocks and chalcedony with minor chert, quartz, and granite	6
5	Mudstone, pale-red (5R6/2); silty, calcitic, 1 ft to massive-bedded, irregular nodular carbonate accumulation lenses	12
4	Mudstone, same as unit 5, but uncemented and no carbonate accumulations	13
3	Mudstone, grayish-orange-pink (5YR7/2); silty, poorly cemented, calcitic, low-angle crossbedded, 6- to 24-inch beds; pebble lenses contain rounded, mixed volcanic rocks, quartz, and chert clasts; irregular nodular carbonate accumulation lenses	34
2	Sandstone, grayish-orange (10YR7/4); poorly sorted, medium-grained, poorly cemented, calcitic; pebbly, coarse sandstone lenses contain mixed volcanic rocks, chert, quartz, and red sandstone clasts	16
	Rincon Valley Formation (total exposed thickness)	25
1	Mudstone, light-brown (5YR6/4) to pale-reddish-brown (10R5/4); silty, 1- to 4-inch beds; few channels to 2-ft thickness of argillaceous very fine sandstone; base not exposed	25

Massacre Peak section—West-northwestward from Howard Tank to top of Massacre Peak in southeast corner of Good Sight Peak NE quadrangle; color code (in parentheses) from soil color charts by Munsell Color Co., Inc.

Unit	Description	Thickness (ft)
	Uvas Basaltic Andesite (total thickness)	83
7	Basaltic andesite (hawaiite), dark-gray (N3), dense, vesicular; forms ledge	83
	Bell Top Formation (total exposed thickness)	596
	Upper sedimentary member (total thickness)	210
6	Mostly covered; cobble conglomerate, coarse sandy matrix; subangular to subrounded andesite-latite clasts; poorly bedded, poorly cemented; forms slope	108
5	Mostly covered; tuffaceous, very fine sandstone, pale-yellowish-brown (10YR7/2); thick-bedded to massive-bedded; forms slope	85
4	Mostly covered; tuffaceous mudstone, very pale orange (10YR8/2); abundant small pumice clasts; forms slope	17
	Tuff 6 member (total thickness)	112
3	Vitric-crystal ash-flow tuff, grayish-pink (5R7/2); lower 80 ft (approximately) is dense, gradational upward to less welded, more porous rock; pinkish-gray (5YR8/1) pumice fragments to 5 cm; few grayish-red (5R4/2) rock fragments to 1 cm; plagioclase, sanidine, quartz, and biotite crystals; forms cliff	112
	Middle sedimentary member (total exposed thickness)	274
2	Tuffaceous, very fine sandstone, yellowish-gray (5Y8/1); few granule-sized white pumice fragments; massive-bedded; partly covered; forms slope	190
1	Tuffaceous, muddy, conglomeratic sandstone and mudstone, grayish-orange-pink (10R8/2); friable, medium-bedded to thick-bedded; mostly covered; forms slope; base not exposed, but nearby in a few gullies cobble conglomerate appears to underlie this unit	84

Appendix 2

Petrographic data for ash-flow tuffs

Crystal Composition of Kneeling Nun Tuff

Sample	Quartz	Sanidine	Plagioclase	Biotite	Hornblende	Sphene	Total
76RC14	9.0	8.8	18.4	2.8	-----	----	39.0
77RC56	12.3	15.6	11.2	0.9	tr.	tr.	40.0
77RC57	12.3	12.6	9.1	0.7	0.2	tr.	34.9
77RC59	19.2	13.4	8.1	0.6	0.2	----	41.5
77RC64	2.6	11.7	13.0	1.8	0.1	----	29.2
77RC64A	3.3	10.9	17.1	1.3	0.5	tr.	33.1
77RC64B	6.8	12.3	13.2	1.5	0.7	0.1	34.6
77RC66A	7.6	10.0	14.6	1.2	-----	----	33.4
77RC66B	5.8	12.0	12.2	2.0	0.3	tr.	32.3
77RC71A	15.3	18.2	6.7	1.5	-----	tr.	41.7
77RC71B	12.5	14.9	11.3	0.7	0.1	0.1	-39.6
77RC72	7.1	11.1	10.3	1.4	-----	tr.	30.1
77RC81A	6.8	12.8	15.2	1.1	0.4	tr.	36.3
77RC81B	6.1	10.9	15.8	1.1	1.0	0.1	35.0
77RC83	7.1	10.5	12.7	1.6	0.8	tr.	32.7
77RC97	7.9	13.8	13.9	0.9	0.2	----	36.7
77RC119A	8.1	11.6	14.3	0.7	-----	----	34.7
77RC119B	12.2	13.2	6.1	0.7	-----	----	32.2
77RC120A	10.3	12.6	8.8	0.6	0.2	tr.	32.5
77RC120B	16.7	12.3	6.8	0.3	tr.	tr.	36.1
77RC123	7.9	11.7	13.1	1.2	0.3	0.1	34.3
77RC123A	12.0	16.5	9.5	0.7	-----	----	38.7
77RC123B	13.4	14.8	8.2	1.3	-----	tr.	37.7
77RC127A	10.9	13.3	11.9	1.0	-----	----	37.1
77RC127B	12.6	14.0	10.2	1.2	tr.	0.2	38.0
Average	9.8	12.8	11.7	1.2	0.2	tr.	34.5

Sample Locations:

76RC14: NW¼ NW¼ sec. 17, T. 17 S., R. 7 W., Hillsboro quad.
77RC56: SE¼ NE¼ sec. 11, T. 19 S., R. 6 W., Nutt quad.
77RC57: NW¼ NE¼ sec. 11, T. 19 S., R. 6 W., Nutt quad.
77RC59: SE¼ SE¼ sec. 2, T. 19 S., R. 6 W., Nutt quad.
77RC64: SW¼ NW¼ sec. 14, T. 19 S., R. 6 W., Nutt quad.
77RC66: NE¼ NW¼ sec. 14, T. 19 S., R. 6 W., Nutt quad
77RC71: SE¼ NW¼ sec. 14, T. 19 S., R. 6 W., Nutt quad.
77RC72: SE¼ SW¼ sec. 18, T. 18 S., R. 7 W., Lake Valley quad.
77RC81: SW¼ SE¼ sec. 27, T. 21 S., R. 8 W., Massacre Peak quad.
77RC83: SE¼ SE¼ sec. 34, T. 21 S., R. 8 W., Massacre Peak quad.
77RC97: NE¼ SW¼ sec. 22, T. 19 S., R. 6 W., Nutt quad.
77RC119: NE¼ SE¼ sec. 26, T. 17 S., R. 7 W., Hillsboro quad.
77RC120: NE¼ SE¼ sec. 26, T. 17 S., R. 7 W., Hillsboro quad.
77RC123: NW¼ NE¼ sec. 13, T. 18 S., R. 7 W., Lake Valley quad.
77RC127: SW¼ SE¼ sec. 8, T. 19 S., R.10 W., Dwyer quad.

Crystal Composition of Tuff 6

Sample	Quartz	Sanidine	Plagioclase	Biotite	Hornblende	Sphene	Total
76RC95	3.6	10.4	11.9	1.1	0.4	tr.	27.4
76RC96	4.5	8.1	11.7	2.0	0.8	tr.	27.1
77RC33	0.7	7.9	19.7	2.0	0.1	----	30.4
77RC34	4.3	8.9	6.7	0.7	0.4	----	21.0
77RC39	4.2	9.8	14.5	1.3	0.7	tr.	30.5
77RC40	1.9	6.2	13.6	1.6	0.3	tr.	23.6
77RC111	6.7	8.3	9.6	1.8	0.2	tr.	26.6
77RC133A	2.6	4.2	9.8	1.8	0.3	----	18.7
77RC133B	1.5	3.5	12.3	1.6	0.2	----	19.1
Average	3.3	7.5	12.2	1.6	0.4	tr.	24.9
*	2.4	7.9	7.5	1.6	0.1	----	19.5

* Average of 47 samples from Sierra de las Uvas

Sample Locations:

76RC95: SE¼SE¼ sec. 22, T. 21 S., R. 6 W., Good Sight Peak quad.
76RC96: SE¼SE¼ sec. 22, T. 21 S., R. 6 W., Good Sight Peak quad.
77RC33: SE¼NE¼ sec. 27, T. 20 S., R. 6 W., Nutt quad.
77RC34: SE¼NE¼ sec. 27, T. 20 S., R. 6 W., Nutt quad.
77RC39: SE¼SW¼ sec. 14, T. 20 S., R. 6 W., Nutt quad.
77RC40: NE¼SW¼ sec. 14, T. 20 S., R. 6 W., Nutt quad.
77RC111: NE¼SE¼ sec. 3, T. 20 S., R. 6 W., Nutt quad.
77RC113: SE¼SE¼ sec. 16, T. 20 S., R. 4 W., Nutt quad.

Contents of pocket

Sheet 1—Geologic maps of Myndus, Lazy E Ranch, Good Sight Peak NE, and Good Sight Peak quadrangles; also south half Nutt 15' quadrangle

Sheet 2—Geologic map of northwest quarter, Nutt 15' quadrangle; cross sections

Type faces: Text in 10-pt. Baskerville, leaded two points
References in 8-pt. Baskerville, leaded two points
Display heads in 24-pt. Baskerville

Presswork: Miehle Single Color Offset
Harris Single Color Offset

Binding: Saddlestitched

Quantity: I M

Paper: Cover on 65-lb. Buckeye French Gray
Text on 70-lb. white mate

Ink: Cover—PMS 553
Text—Black

Base from U.S. Geological Survey

Section lines for Nutt NW., Nutt SW., and Nutt SE. quadrangles are approximate; base for these quadrangles was constructed from USGS preliminary maps

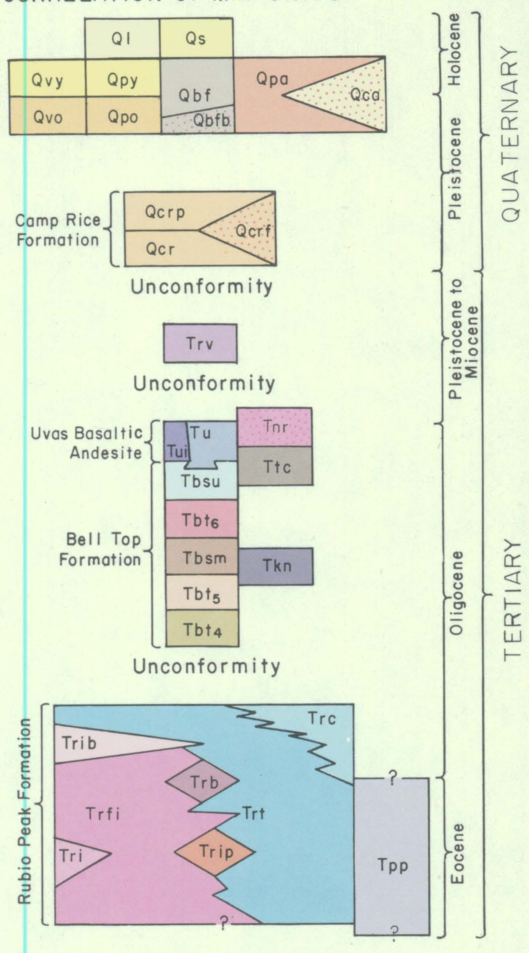
Geology by Russell E. Clemons 1976–1977

GEOLOGY OF GOOD SIGHT MOUNTAINS AND UVAS VALLEY

by R. E. Clemons, 1979

SCALE 1:48,000

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Ql Ephemeral-lake sediments — *Deposits of clay-silt beneath the floors of small closed depressions on ancient basin-floor surfaces*

Qs Windblown sand—*Unconsolidated dunes up to 20 ft; mostly underlain by caliche horizon; forms cover over map unit shown by symbol under the line (for example, Qs/Qpa)*

Qbf Basin-floor sediments—*Dominantly non-gravelly to slightly gravelly alluvium in the Mimbres Basin and Uvas Valley unaffected by arroyo incision; main part of unit appears to grade to Qpo unit in piedmont toe-slope position*

Qbfb Beach-bar sediments—*Fine- to coarse-grained sand and slightly gravelly sand deposited as a wave-built bar along northern shore of last stage (deepest part) of Lake Goodsight*

Qca Undifferentiated colluvium-alluvium—*Thin talus-slope veneers and colluvial and alluvial fills on arroyo valley sideslopes, in mountain canyons, and on piedmont slopes*

Qpa Undifferentiated piedmont-slope alluvium—*Complexly intermixed older piedmont-slope alluvium and younger piedmont-slope arroyo alluvium (Qpo and Qpy)*

Qpo Older piedmont-slope alluvium—*Unconsolidated fan deposits, piedmont valley fills, and erosion surface veneers, associated with surfaces graded to closed basins; uppermost beds often cemented with pedogenic carbonate*

Qpy Younger piedmont-slope arroyo alluvium—*Fills (silty to gravelly) of shallow drainageways cut below older fan and erosion surfaces graded to closed basins*

Qvo Older valley-slope alluvium—*Arroyo fan and terrace deposits and erosion surface veneers (boulder gravel to silt-clay) associated with graded surfaces formed during valley entrenchment and partial back-filling of the Rio Grande; apparent age equivalent of Qpo unit*

Qvy Younger valley-slope alluvium—*Arroyo deposits (boulder gravel to silt-clay) associated with graded surfaces formed during the last major Rio Grande entrenchment and backfilling; apparent age equivalent of Qpy unit*

Qcrf Fluvial facies—*Sand, gravelly sand, gravel, sandstone, and conglomeratic sandstone, with minor clay-silt and mudstone; deposited by Rio Grande; thickness to 334 ft*

Qcrp Piedmont-slope facies—*Fan gravel and fanglomerate with interbedded sandy zones; includes thin erosion-surface veneers near mountain fronts; upper layers contain thick carbonate accumulations (caliche) to 50 ft thick; overlaps and appears to intertongue with upper Qcrf beds; thickness to 300 ft*

Qcr Undifferentiated Camp Rice Formation—*Predominantly piedmont-slope facies without strong carbonate accumulation; may include some fluvial facies in northeast part of map*

Trv Rincon Valley Formation—*Bolson-fill deposits; reddish-brown mudstone in basin centers grades into reddish-brown fanglomeratic sandstone and conglomerate at basin margins; not exposed in map area but shown in subsurface on cross sections; thickness to 810 ft*

Tnr Nutt Mountain rhyolite—*Flow-banded, slightly porphyritic rhyolite intrusions and short flow; outcrops restricted to vicinity of Nutt Mountain*

Tu *Highly vesicular basaltic andesite (hawaiite) flows and minor interbedded sandstone and conglomerate; thickness 0-300 ft*

Tui *Dense, basaltic andesite plug, vent, and dikes*

Ttc Tenaga Canyon formation—*Undifferentiated flows and intrusions of medium- to dark-gray andesite-latite; several larger intrusions are porphyritic hornblende latite; interbedded with upper sedimentary member of Bell Top Formation and intruded by Uvas Basaltic Andesite*

Tbsu Upper sedimentary member—*Pale-yellowish-brown and grayish-orange tuffaceous siltstone, sandstone, and conglomerate generally poorly sorted, poorly bedded, and partially consolidated; some lenticular channel fills; interfingers with lower Uvas flows; thickness 50-300 ft*

Tbt_6 Tuff 6 member—*Pale-grayish-red, vitric-crystal ash-flow tuff; contains 15-30 percent phenocrysts of plagioclase, sanidine, quartz, biotite, and hornblende; abundant flattened pumice fragments; thickness 0-112 ft*

Tbsm Middle sedimentary member—*Grayish-orange-pink tuffaceous mudstone, sandstone, and conglomerate; generally poorly sorted, poorly bedded, and poorly consolidated; thickness 50-260 ft*

Tbt_5 Tuff 5 member—*Grayish-pink, crystal-vitric ash-flow tuff, contains 18-35 percent phenocrysts of sanidine, quartz, plagioclase, and biotite; abundant small pumice fragments; thickness 0-50 ft; not exposed in map area but shown in subsurface on cross sections*

Tbt_4 Tuff 4 member—*Pale-grayish-red-purple, vitric-crystal ash-flow tuff; contains 5-20 percent phenocrysts of plagioclase, sanidine, quartz, and biotite; thickness 0-30 ft*

Tkn Kneeling Nun Tuff—*Grayish-pink to pale-red, crystal-vitric ash-flow tuff; contains 29-42 percent phenocrysts of sanidine, quartz, oligoclase, and biotite, with minor hornblende, sphene, clinopyroxene, and apatite; abundant flattened pumice fragments; thickness 0-100 ft*

Trc Conglomerate and breccia—*Brown, dark-gray, purple, greenish-gray, and black andesite-latite fragments with minor coarse sandstone lenses; poorly bedded; represents alluvial facies of Good Sight Mountains vent-zone erosional debris; gradational and interfingering with* Trt *unit near vents; correlative to upper part of Palm Park Formation; base not exposed; maximum exposed thickness about 1,000 ft*

Trt Tuff breccia—*Grayish-orange, light-gray, and dark-gray talus, lahars, and vent breccias(?); monolithic and heterolithic types about equally abundant; boulders to 20 ft surrounded by tuffaceous material; bedding generally indistinct except in minor, thin, sandy lenses; one notable exception in secs. 14 and 23, T. 22 S., R. 6 W; maximum thickness about 1,000 ft*

Trib Intrusive breccia—*Greenish-gray andesite-latite angular blocks gradational into or surrounded by vertically sheeted and banded rock of same composition*

Trb Breccia—*Greenish-gray, purple, and reddish-brown andesite-latite flow breccia, talus, or intrusive breccia undifferentiated*

Trip Intrusive porphyry—*Light-gray, medium-gray, and grayish-red latite-dacite dikes, plugs, and small stocks; contain up to 50 percent phenocrysts of plagioclase, hornblende, hypersthene, augite, and biotite*

Tri Nonporphyritic intrusives—*Greenish-gray and dark-gray hornblende-biotite andesite and latite dikes, sills, plugs, and small stocks*

Trfi Undifferentiated flows and intrusions—*Dark-gray, greenish-gray, and brown andesite-latite; thinly laminated to dense massive, intrusive-extrusive complexes; mineralogy similar to* Trip

Tpp Palm Park Formation—*Gray, red, and purple tuffaceous mudstone, sandstone, breccia, and conglomerate; consisting chiefly of andesite-latite detritus; indistinguishable from* Trc *unit of Rubio Peak Formation; arbitrary boundary chosen as valley fill by Lazy E Ranch with* Tpp *to east and* Trc *to west; maximum thickness about 3,500 ft*

Contact—*Dashed where approximately located; dotted where used to separate some units within the undifferentiated Rubio Peak flows and intrusions*

Fault—*Dashed where approximate; dotted where concealed; ball on downthrown side*

Syncline—*Showing axis and direction of plunge; dashed where approximate*

8 Strike and dip of beds—*Inclined*

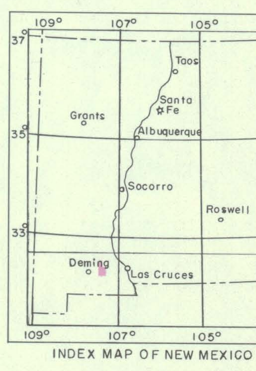
vertical inclined 12 Strike and dip of foliation—*Inclined; vertical*

Tu 130 Tbsu 220 o B 424 Water well—*Showing depth, in feet, to tops of map units and bottom of hole (B)*

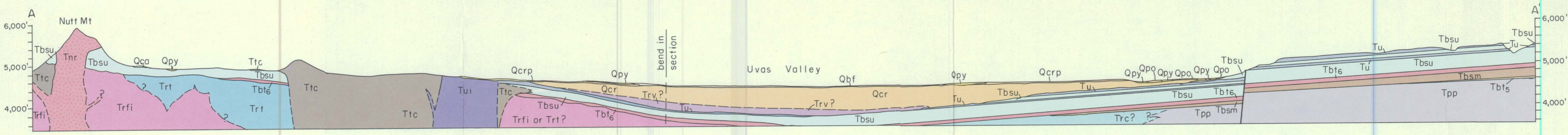
Gravel quarry

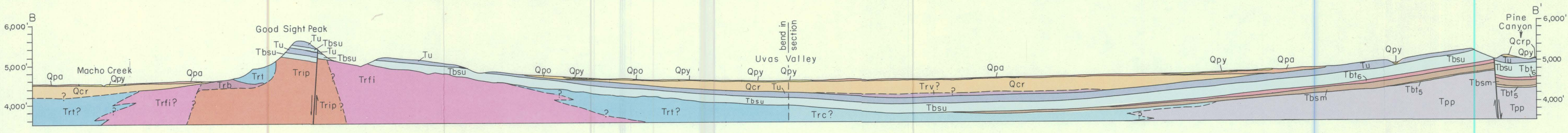
TRUE NORTH
MAGNETIC NORTH

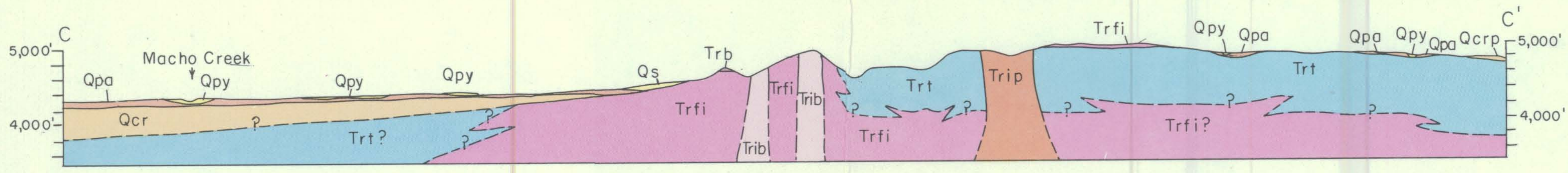
APPROXIMATE MEAN DECLINATION, 1975



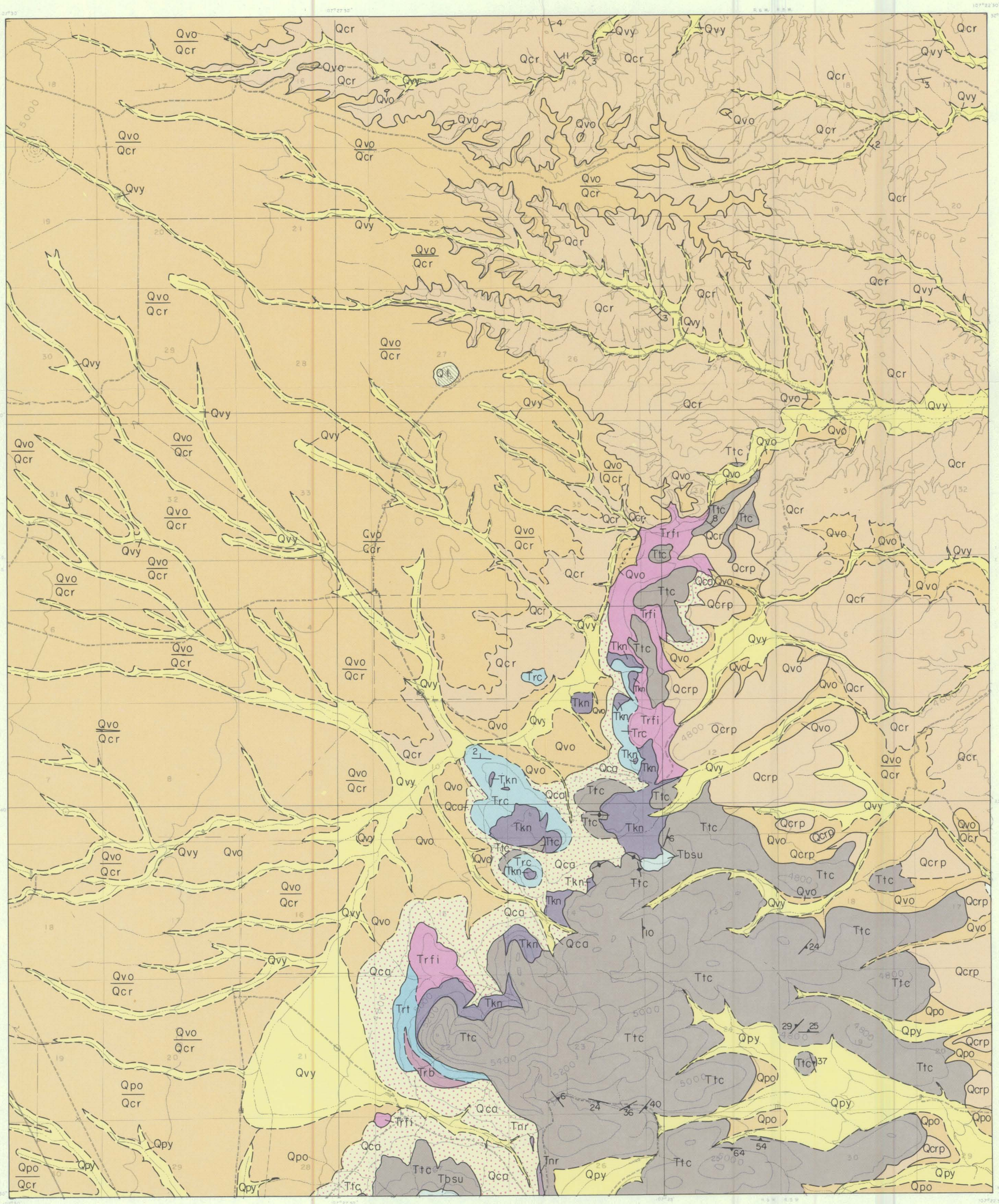
INDEX MAP OF NEW MEXICO







Cross sections marked on sheet 1.

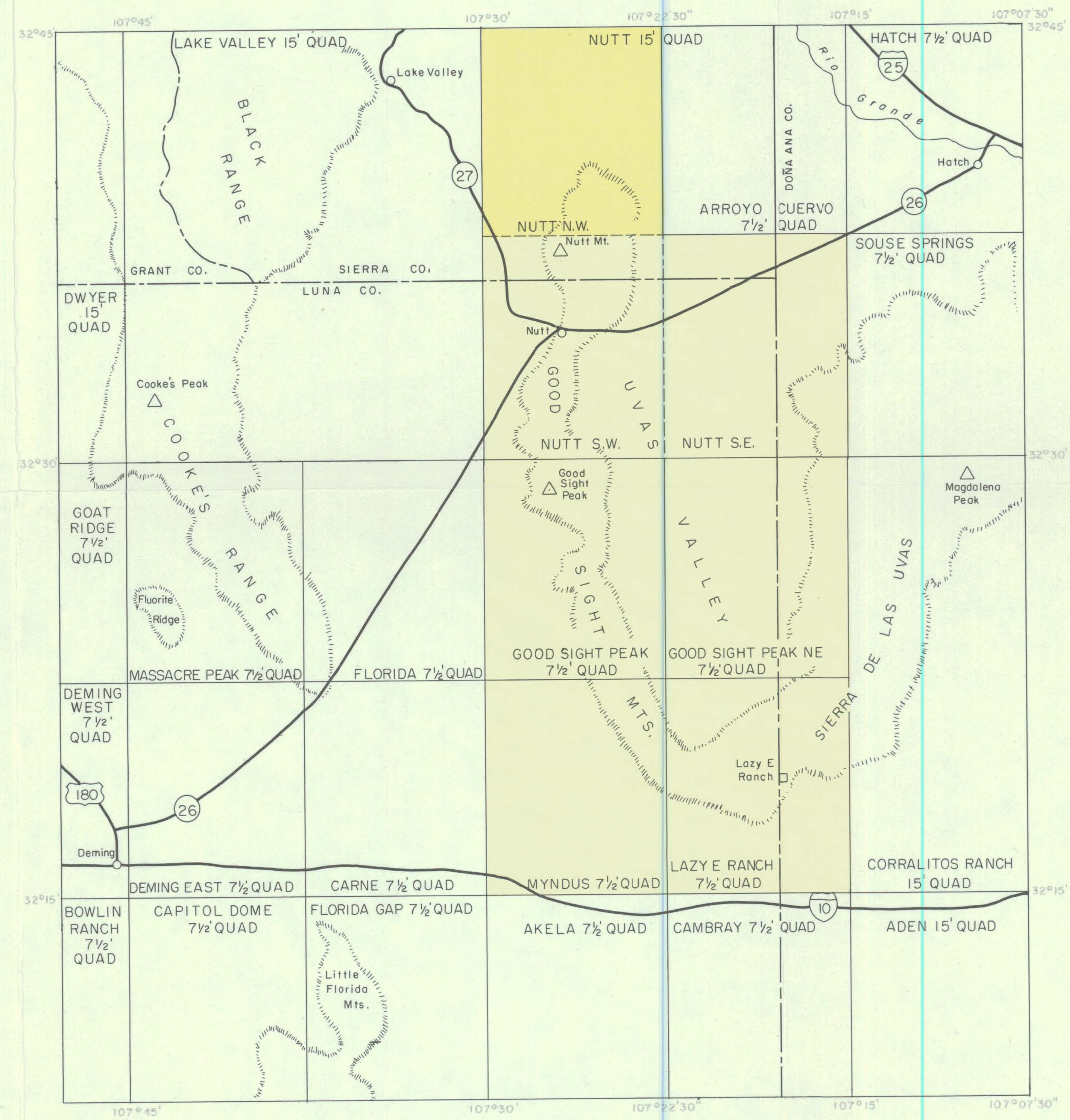


Base from U.S.Geological Survey

Geology by Russell E. Clemons 1976-1977

SCALE 1:48,000

Section lines for Nutt NW., Nutt SW., and Nutt SE. quadrangles are approximate; base for these quadrangles was constructed from USGS preliminary maps.



Index map of region; lightly shaded area represents sheet 1, and darker area represents sheet 2.

Trim along dashed lines and glue or tape to dashed line on sheet 1.

GEOLOGY OF GOOD SIGHT MOUNTAINS AND UVAS VALLEY