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Eagle Nest–Granite Hill area, Luna County, New Mexico—a new look at some old rocks

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Introduction

The western perimeter of the West Potrillo Mountains is a remote, desolate land with few roads, few visitors, and few outcrops. Waterless and treeless, much of the area is covered by seemingly endless expanses of sand, and only here and there do isolated hills of bedrock project above the sand drifts. Two of the more prominent hills are Eagle Nest and Granite Hill, located in southeastern Luna County approximately 30 km (19 mi) northeast of Columbus (Fig. 1).

Perhaps because of their remoteness, these hills are not well known, even though they have been visited occasionally by geologists for more than 80 years. Published accounts are varied, contradictory, and brief, although an excellent recent M.S. thesis presented details of the geology of Granite Hill (Broderick, 1984). There seem to be long standing disagreements among previous workers about the general age and structure of rocks at Eagle Nest and Granite Hill.

In 1916 Darton portrayed Eagle Nest outcrops as Pennsylvanian in age, whereas those at Granite Hill, one kilometer farther east, he considered to be Tertiary "agglomerate" intruded by Tertiary granite porphyry. Dane and Bachman (1965) concurred with the Tertiary-age assignment of the granite at Gran-

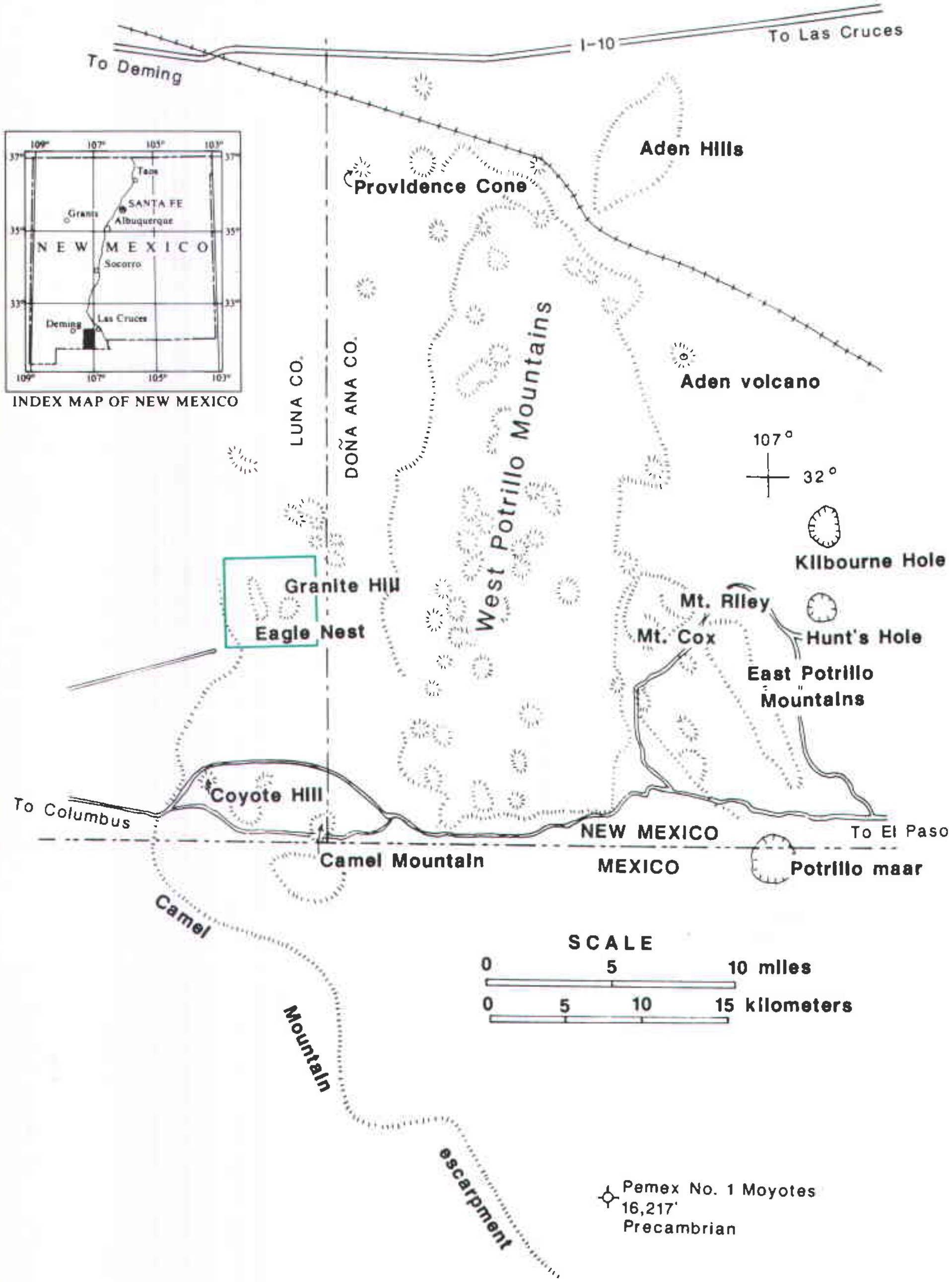

FIGURE 1—Location map of Eagle Nest–Granite Hill area (from Seager, 1989). The area of Fig. 9 is shown by the rectangle.

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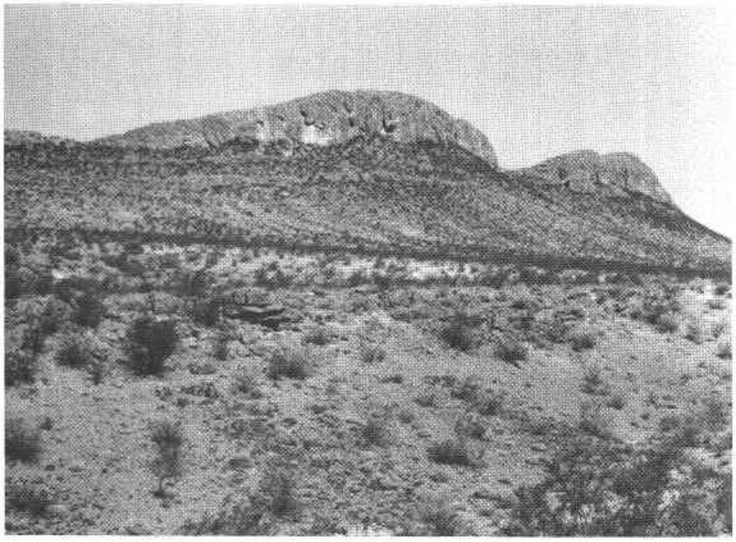

FIGURE 2—Eagle Nest ridge capped by cliff-forming Permian carbonates above overturned Lower Cretaceous strata. Laramide thrust truncates carbonates at base of cliff. View looks northwestward.

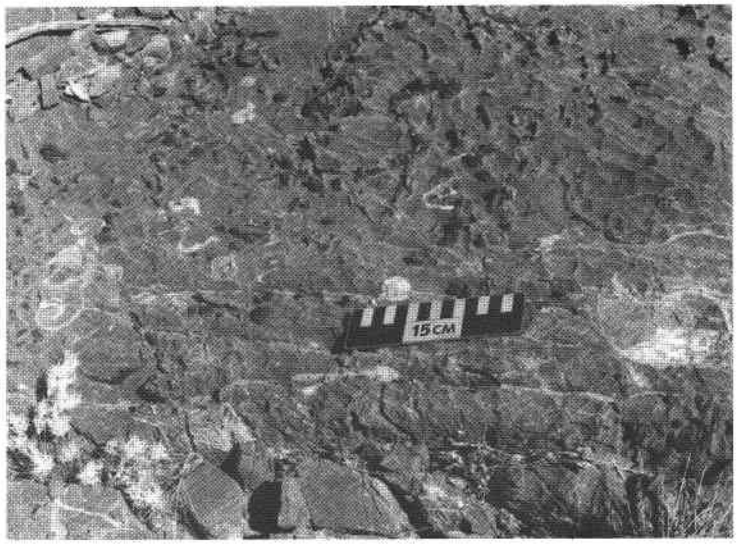

FIGURE 3—Gastropods and nautiloid in Colina (uppermost Hueco) Formation at Eagle Nest.

ite Hill but considered the sedimentary rocks at both Granite Hill and Eagle Nest to be Cretaceous. Hoffer (1976) agreed with Dane and Bachman's (1965) age assignments of the rocks in both outcrops. However, in 1981 Hoffer and Hoffer reported the sedimentary rocks at Granite Hill to be Early Cretaceous, and in 1983 Hoffer and Hoffer assigned the entire section at Eagle Nest to the Early Cretaceous and considered it to be right side up. They recovered Lower Cretaceous fossils from part of the Eagle Nest section. Mack et al. (1986) also believed that the Lower Cretaceous strata at Eagle Nest were right side up but additionally recognized that an upper, massive, cliff-forming limestone was separated from lower beds by a low-angle fault. Broderick (1984) mapped Granite Hill and considered the granite to be Precambrian in age, overlain by Lower Cretaceous arkosic strata; this view was repeated by Broderick et al. (1986).

Our interpretations of Granite Hill and Eagle Nest differ significantly from previously published accounts. In this report we present evidence that Lower Cretaceous strata at Eagle Nest are upside down and that they are overlain by a thrust sheet of Permian carbonates. Right-side-up sedimentary strata at Granite Hill, which nonconformably overlie Precambrian granite and are intruded by middle Tertiary(?) dikes, are latest Cretaceous or early Tertiary in age. The two hills, Eagle Nest and Granite Hill, are separated by a major fault zone whose geometry and history of movement are somewhat speculative. These conclusions were reported by Seager (1989; in press).

Regional setting

The Eagle Nest–Granite Hill area is part of four tectonic elements of different ages. It may be within the Burro–Florida–Moyotes uplift of mid-Wolfcampanian age (Kottlowski 1960; 1963; Navarro and Tovar, 1975; Greenwood et al., 1977; Wilson and Jordan, 1988; Thompson et al. 1978; Seager, 1989). A basement-cored uplift of the Ancestral Rockies system, the Burro–Florida–Moyotes uplift resulted in erosion of various thicknesses of pre-mid-Wolfcampian strata and, perhaps locally, nondeposition of Pennsylvanian strata.

In Early Cretaceous time the Eagle Nest area was part of the rift basin of Mack et al. (1986; 1988) that filled with arkosic marine and nonmarine sediments. Granitic rift shoulders along the northern and northeastern margins of the rift furnished much of the arkosic sediment.

In Laramide time (Late Cretaceous to early Tertiary) both Eagle Nest and Granite Hill were part of a zone of thrusting, basement-cored uplifts, and basin formation extending from west Texas northwestward into southeastern Arizona. Controversy continues over the dominant style of deformation in this region: regional overthrusting or foreland-style basement-block uplifts (e.g. Drewes, 1978; Davis, 1979; Seager and Mack, 1986).

Finally, both Eagle Nest and Granite Hill are part of the late Tertiary Camel Mountain fault block (Seager, 1989), one of the many fault-block uplifts in the southern part of the Rio Grande rift. Tilted eastward 15 to 20 degrees, the Camel Mountain fault block is nearly buried by Quaternary sand and basalt. Structurally high hills such as Eagle Nest and Granite Hill, as well as the prominent Quaternary fault scarp along the western margin of the block (Camel Mountain escarpment, Fig 1.), constitute some of the geologic evidence for the presence and extent of the fault block.

Stratigraphy

Precambrian rocks

Brown to grayish-orange granite crops out along the western base of Granite Hill. Although interpreted as Tertiary in age by some previous workers (Darton, 1916; Dane and Bachman, 1965; Hoffer, 1976), the coarse-grained granite is typical of much of the Precambrian basement of south-central New Mexico. Recognizing this, Broderick (1984) and Broderick et al. (1986) assigned the granite a Precambrian age, a correlation with which we concur.

According to Broderick (1984) the granite contains 55–60% anhedral orthoclase microperthite, and 35–40% anhedral quartz. Sericite, pyrite, and hematite are common secondary minerals. The granite contains approximately 73% SiO_2 (Broderick et al., 1986).

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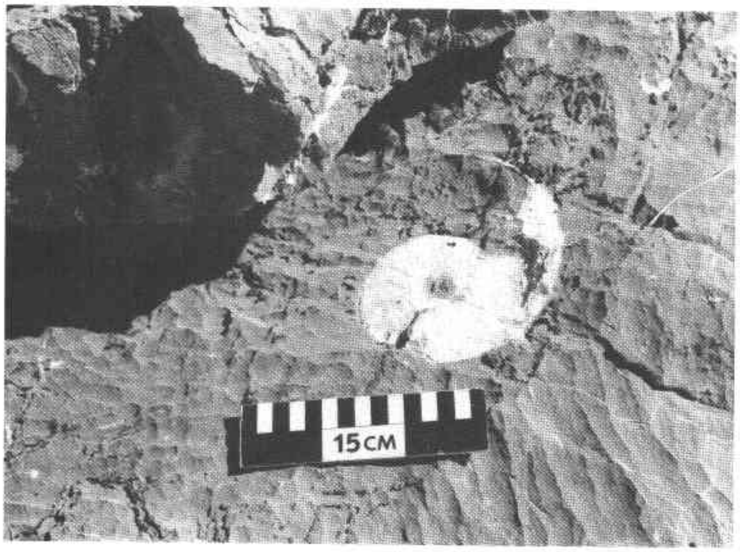

FIGURE 4—Nautiloid in Colina (uppermost Hueco) Formation at Eagle Nest.

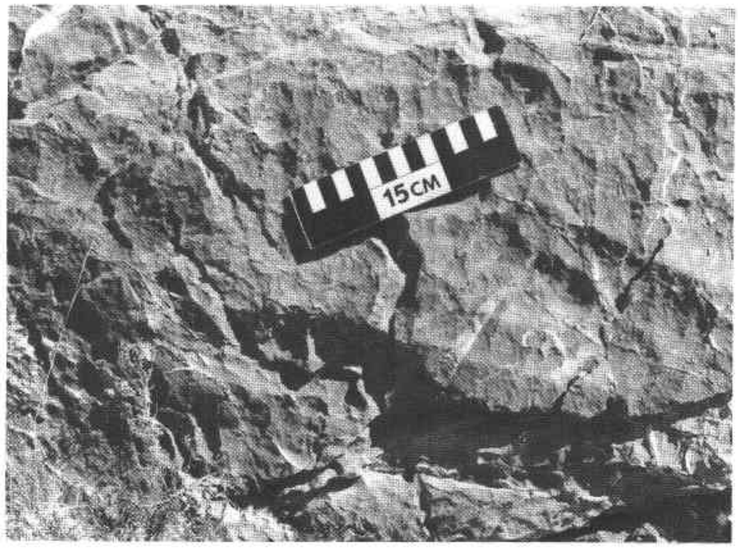

FIGURE 5—Cephalopods in Colina (uppermost Hueco) Formation at Eagle Nest (below scale).

The mineral composition, silica content, and very coarse grained texture is consistent with other Precambrian granitic rocks of south-central New Mexico. It is strikingly dissimilar in terms of texture and composition to Tertiary-age stocks in the Tres Hermanas, Organ and Jarilla Mountains, and Cooke's Range. It also is dissimilar to the lower Paleozoic syenitic stocks of the Florida Mountains (Evans and Clemons, 1988).

Permian rocks

Carbonate rocks of probable Permian age form the prominent ridge and cliff at Eagle Nest (Fig. 2). Seemingly in normal stratigraphic order, the strata compose the hanging wall above a Laramide thrust fault. Tentatively, we correlate the Permian section with the Yeso Formation and uppermost beds of the Hueco Formation of south-central New Mexico (e.g., Kottlowski et al., 1956) and with the Epitaph and Colina Formations of southwestern New Mexico (Zeller, 1965).

Cliff-forming, thick-bedded limestone of the Colina (uppermost Hueco) Formation overlies the thrust fault. These massive, dark-gray to blue-gray limestone beds are at least 150 m (492 ft) thick. Some horizons contain abundant chert nodules while other beds are relatively chert free. Robust, planispiral gastropods are common in many parts of the formation as are bivalves, silicified rugose corals, small and large coiled nautiloids, and orthoconic nautiloids (Figs. 3, 4, 5).

The presence of rugose corals and small orthoconic nautiloids (*Mooreoceras*(?)) indicates a Paleozoic age for the carbonate section (D. V. LeMone, personal communication, 1989). The strata have none of the lithologic characteristics of lower to middle Paleozoic strata in the region and are almost certainly Permian. Rock types and fauna are most nearly like those seen in uppermost Hueco strata in the El Paso area (D. V. LeMone, personal communication) and like those reported for the Colina Limestone of southwestern New Mexico (Zeller, 1965). Consequently we tentatively assign this section to the Colina (uppermost Hueco) Formation.

Strata that we correlate with the Epitaph (Yeso) Formation occur conformably(?) above the Colina (uppermost Hueco) Formation in the northernmost hills at Eagle Nest. Thin- to medium-bedded, cherty, dolomitic limestone is the common rock type. Beds are alternately light gray to medium gray. Numerous siliceous "eyes" are common. Fossils are comminuted, silicified, and unidentified. Approximately 100 m (328 ft) of Epitaph (Yeso) section is exposed, although part of this is obscured by sand. The base of the formation also is covered by sand.

Our assignment of these dolomitic carbonates to the Epitaph (Yeso) Formation is based on physical correlation with similar dolomitic carbonates in the East Potrillo Mountains (Seager and Mack, in press) and the West Lime Hills of the Tres Hermanas Mountains. In the East Potrillo Mountains the dolomitic carbonates contain beds of soft, yellow sandstone and underlie massive carbonates thought to be San Andres Limestone (Seager and Mack, in press). Dolomitic carbonates in the West Lime Hills are lithologically similar to those of Eagle Nest and the East Potrillo Mountains and have yielded middle Permian (early Leonard) fossils (Thompson, 1982).

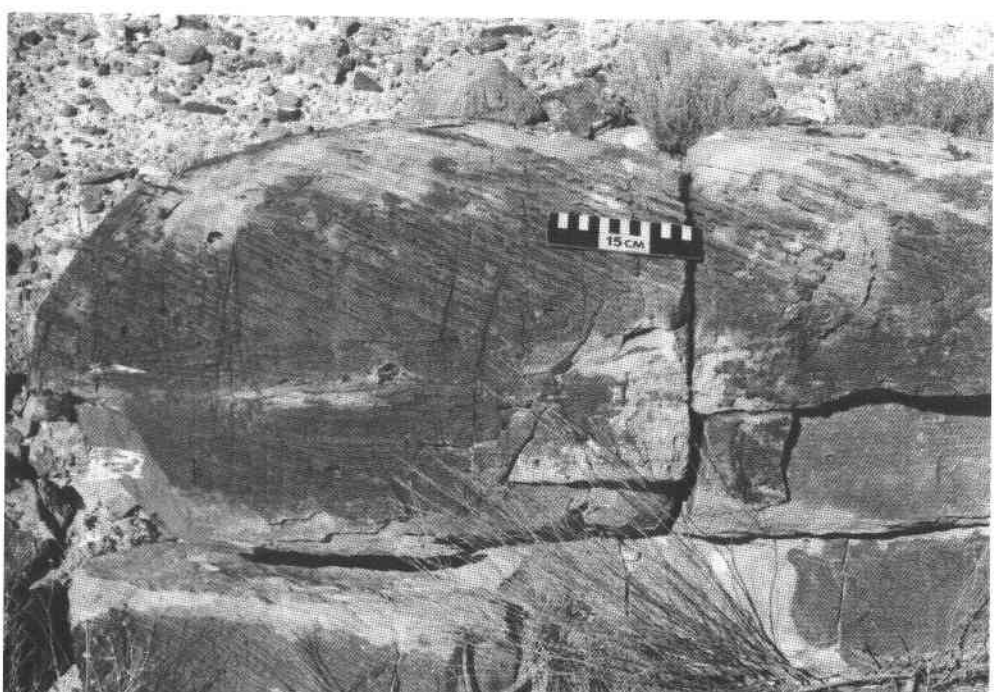

FIGURE 6—Overturned crossbedding in sandstone of sandstone–limestone member of the U-Bar Formation.

Lower Cretaceous rocks

Approximately 288 m (945 ft) of Lower Cretaceous sedimentary rocks are exposed east of Eagle Nest in the overturned limb of the syncline (Fig. 6). An Early Cretaceous age for these rocks is based on the presence of rudistid clams, which are restricted to Lower Cretaceous rocks in southwestern New Mexico, and on lithologic correlation with Lower Cretaceous rocks in the East Potrillo Mountains (Fig. 7; Zeller, 1965; Mack et al., 1986; Seager and Mack, in press). Lower Cretaceous rocks at Eagle Nest are divided into the Hell-to-Finish and U-Bar Formations (Fig. 7), a nomenclature originally defined by Zeller (1965) in the Big Hatchet Mountains.

At Eagle Nest the Hell-to-Finish Formation is 153 m (502 ft) thick and is subdivided into lower conglomerate and arkosic sandstone members (Fig. 7). The lower conglomerate member is 30 m (98 ft) thick, although the base is not exposed due to truncation by a fault. The conglomerate member is composed of beds 1.5 to 4.5 m (5 ft to 15 ft) thick of grain-supported cobble and boulder conglomerate. Clasts in the conglomerate are well rounded and consist of limestone, dolomite, chert, and sandstone. Conglomerates are interbedded with red shale and thin (<1 m) micritic limestone. The upper member of the Hell-to-Finish Formation is 123 m (403 ft) thick and is characterized by several distinctive beds as much as 6 m (20 ft) thick of massive, pink, pebbly arkosic sandstone. Also present are limestone and chert pebble and cobble conglomerate, thin (<1 m) (3 ft) micritic limestone, and red silty shale.

The conformable contact between the Hell-to-Finish and U-Bar Formations is placed above the uppermost pink arkose. The exposed thickness of the U-Bar Formation is 135 m (443 ft). The unit is separated into five members, which in ascending order are: the lower limestone, sandstone, rudistid limestone, sandstone–limestone, and upper limestone (Fig. 7). The upper contact of the U-Bar Formation is covered beneath Quaternary alluvium.

The lower limestone member of the U-Bar Formation consists of 8 m (26 ft) of thin (<30 cm, 1 ft) beds of gray and tan limestone containing bivalves and gastropods. The abundant, easily recognizable fossils in this member are in sharp contrast to the micrite limestones of the Hell-to-Finish Formation. The lower limestone member is overlain by 12 m (39 ft) of siliciclastic rocks that include a prominent 4-m-thick (13 ft) ledge of gray, fossiliferous, crossbedded, medium to coarse sandstone. Also present are several thin (<1.5 m, 5 ft) beds of fossiliferous pebble conglomerate and gray, bioturbated, silty shale. The sandstone member is overlain by the most distinctive marker bed in the U-Bar Formation, the rudistid limestone member. This member consists of large rudistid clams in growth position and ranges in thickness from 3 to 15 m (10 to 49 ft). The sandstone–limestone member is 75 m (246 ft) thick, although the lower half is poorly exposed beneath Quaternary alluvium. Very fine to medium-grained sandstone, gray shale, and fossiliferous limestone constitute this member. Very fine to fine-grained sandstones display burrows, hummocky cross stratification, and symmetrical ripple marks, whereas a 2-m-thick (7 ft), medium-grained sandstone near the top of the member is crossbedded (Fig. 6). Bivalve and gastropod fossils are common in the interbedded limestones. The upper limestone member (37 m thick, 121 ft) is poorly exposed and consists of beds as thick as 2 m (7 ft) of fossiliferous and intraclastic limestone separated by covered intervals. Also present in the upper limestone member are a few thin (<30 cm, 1 ft) beds of brown siltstone and very fine sandstone.

The Lower Cretaceous section at Eagle Nest correlates in terms of rock type and thickness with Lower Cretaceous rocks exposed 30 km (19 mi) to the east in the East Potrillo Mountains (Fig. 7; Mack, 1986; Seager and Mack, in press). The biggest difference between these stratigraphic sections is the coarser grain size of the arkosic sandstone member of the Hell-to-Finish Formation at Eagle Nest compared to the mottled siltstone member of the Hell-to-Finish Formation in the East Potrillo Mountains. Regional variations in grain size of the Hell-to-Finish Formation are common, however, in response to local tectonism (Mack, 1987).

Upper Cretaceous to lower Tertiary rocks

Sedimentary rocks at Granite Hill (Fig. 8) are approximately 240 m (787 ft) thick and can be separated into four members, following Broderick (1984). The basal conglomerate is 76 m (249 ft) thick and nonconformably overlies Precambrian granite. The contact between the granite and conglomerate is difficult to distinguish because bedding and detrital texture are obscure in the conglomerate and because the conglomerate consists exclusively of clasts derived from the underlying granite. The basal conglomerate fines upward from boulders and cobbles to pebble conglomerate and pebbly sandstone. The basal conglomerate is overlain by 36 m (118

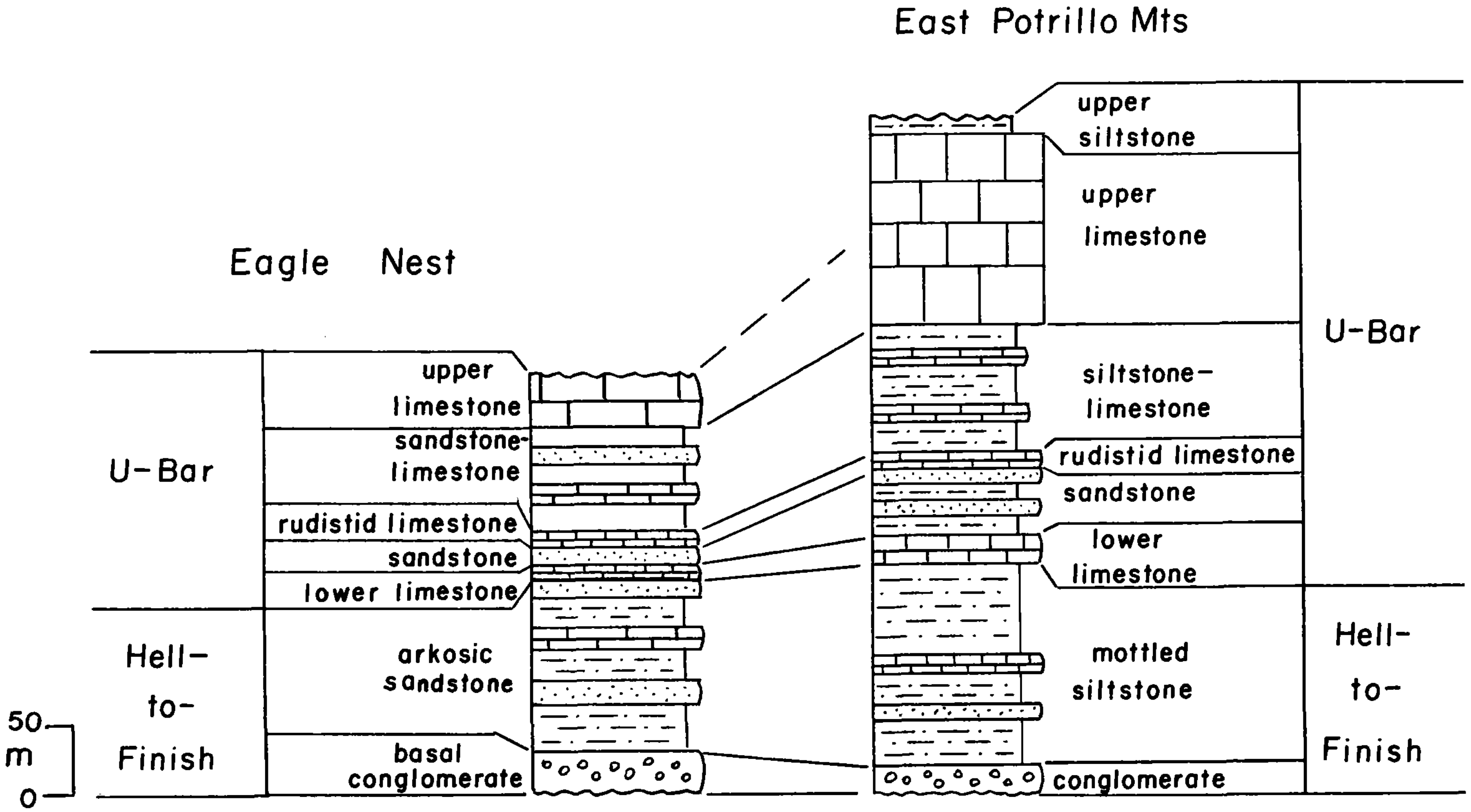

FIGURE 7—Correlation of Lower Cretaceous rocks of Eagle Nest and East Potrillo Mountains.

ft) of interbedded arkosic sandstone and sandy micritic limestone. No fossils were recognized in either rock type, although the sandstones contain a few straight to sinuous, horizontal burrows. The most distinctive member is a 15-m-thick (49 ft) conglomerate composed of well-rounded to subrounded, grain-supported pebbles and cobbles. Clasts are primarily limestone and dolomite, although chert, sandstone, granite, and andesite are also present. A few thin (≤1 m) lenses of sandstone are intercalated within the conglomerate. The upper 113 m (371 ft) of the section consists of interbedded fine to very fine sandstone, siltstone, and limestone. This member is poorly exposed and shale probably underlies many of the covered intervals. Sandstone and siltstone beds are either massive or horizontally laminated and commonly contain straight to sinuous horizontal and vertical burrows. The gray limestones are micritic and sandy and lack recognizable macrofossils. The whole section is crosscut by a porphyritic andesite dike.

Despite the lack of index fossils, sedimentary rocks at Granite Hill can be bracketed as post-Early Cretaceous and pre-middle Tertiary. The sedimentary-clast conglomerate has a few limestone cobbles that contain *Orbitolina*, a foraminiferal genus that in southwestern New Mexico is found only in the Lower Cretaceous U-Bar Formation (Zeller, 1965; Mack et al., 1986). Because there are no unconformities within Lower Cretaceous strata in southwestern New Mexico, the sedimentary rocks at Granite Hill probably postdate not only the U-Bar Formation but also the overlying Mojado Formation. The upper age limit of the sedimentary rocks at Granite Hill is defined by the crosscutting relationship of the porphyritic andesite. Although this dike has not been radiometrically dated, correlation with similar igneous rocks in southern New Mexico indicate that it is probably no younger than middle Tertiary.

In southern New Mexico, post-Lower Cretaceous and pre-middle Tertiary sedimentary rocks can be divided into two distinct sequences. The older sequence is Late Cretaceous in age (Cenomanian–early Campanian), consists primarily of mixed marine and nonmarine fine-grained sandstone and shale, and includes the Dakota, Mancos, and Tres Hermanos Formations and the Mesaverde Group (Mack et al., 1988). The upper sequence ranges from latest Cretaceous to Eocene in age and includes the Ringbone, McRae, Lobo, and Love Ranch Formations (Clemons and Mack, 1988). The younger rocks are entirely nonmarine in origin and display a wide range in grain size from boulder conglomerate to shale. The wide variation in grain size and the lack of evidence for marine deposition suggest that the sedimentary rocks at Granite Hill correlate with uppermost Cretaceous–Eocene rocks. Indeed, the sedimentary rocks at Granite Hill most closely resemble the Lobo Formation exposed in the Florida Mountains (Mack and Clemons, 1988).

Middle(?) Tertiary rocks

Porphyritic andesite dikes crop out extensively at Granite Hill. According to Broderick (1984) the rock consists largely of phenocrysts of andesine and biotite set in an aphanitic matrix. The biotite is pseudomorph after hornblende.

The porphyry dikes transect both Precambrian granite and the overlying Upper Cretaceous to lower Tertiary arkosic section and therefore are younger. Physically, the intrusives are similar to other intermediate-composition dikes, plugs, and stocks of south-central New Mexico that have been dated Eocene to Oligocene in age (Seager, in press).

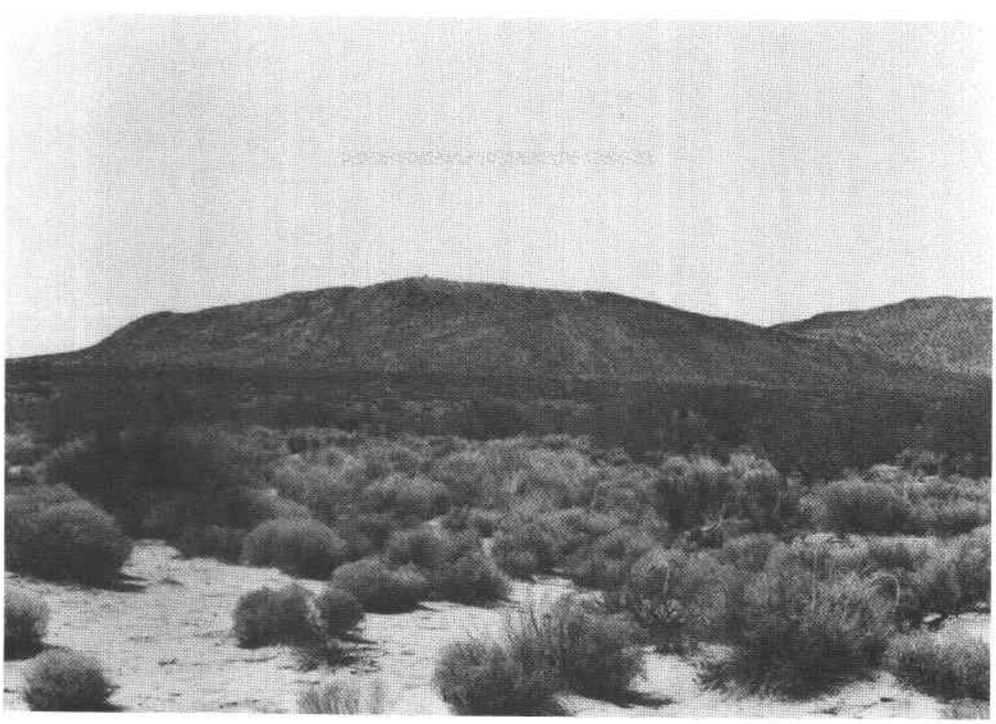

FIGURE 8—Granite Hill. View looks northward. Precambrian granite crops out on left (west) margin of hill. Arkosic strata correlative with the Upper Cretaceous–lower Tertiary Lobo Formation dip to the right (east) and form the rest of the hill.

Structure

The structural contrast between Eagle Nest and Granite Hill is no less striking than the stratigraphic contrast. Figures 9 and 10 illustrate the different structural styles of the two outcrops. Granite Hill appears to be part of a relatively simple northwest-trending basement-cored fault block tilted northeastward (Fig. 8). Eagle Nest, on the other hand, is a segment of a thrust sheet of Permian strata that has moved east–northeast to override the overturned Lower Cretaceous rocks.

As shown in Figure 10, the structure at Eagle Nest may be interpreted as a thrust sheet of strata in normal stratigraphic order beneath which lies an overturned syncline. Vergence is toward the east–northeast and the thrust fault strikes predominantly north–northwest. It dips southwest 30 to 40 degrees and appears to be segmented by at least two east-striking tear faults. Both hanging-wall and footwall strata are truncated by the thrust (Fig. 11), but the stratigraphic separation across the fault is not known. In terms of both structural geometry and rock systems involved in the deformation, the Eagle Nest structure is nearly identical to the Laramide deformation of the East Potrillo Mountains 30 km (19 mi) to the east (Seager and Mack, in press).

The structural relief between Granite Hill and Eagle Nest requires that the two outcrops be separated by a major fault zone, herein named Granite Hill fault (Figs. 9 and 10). Unfortunately, the fault is not exposed. It clearly is downthrown to the west and seemingly trends northwest; whether it is normal, reverse, or thrust is not known. In Figure 10 we show the fault to be normal and steep because the tilted footwall strata of Granite Hill show no indication of compressional-style folding as they approach the fault zone. If the fault is Laramide in age, however, it may be a thrust or reverse fault that dips northeast rather than southwest.

The age of the fault also is uncertain. Several possible times of movement can be inferred on the basis of structural or stratigraphic grounds, but none is well constrained:

1) Uplift in Early Cretaceous time. This possibility is suggested by the coarse tongues of granitic detritus in the Hell-to-Finish Formation of the Eagle Nest area, which may have been derived from uplifted Precambrian granite at Granite Hill. However, the arkose may also have been washed from a more distant, different fault block or from a more distant segment of the Granite Hill block. If the Granite Hill block were the source of these arkoses, the block could have been either an intrarift fault block or the bounding rift shoulder. Furthermore, the Granite Hill fault block surely was buried later in the Early Cretaceous by carbonates of the U-Bar For-

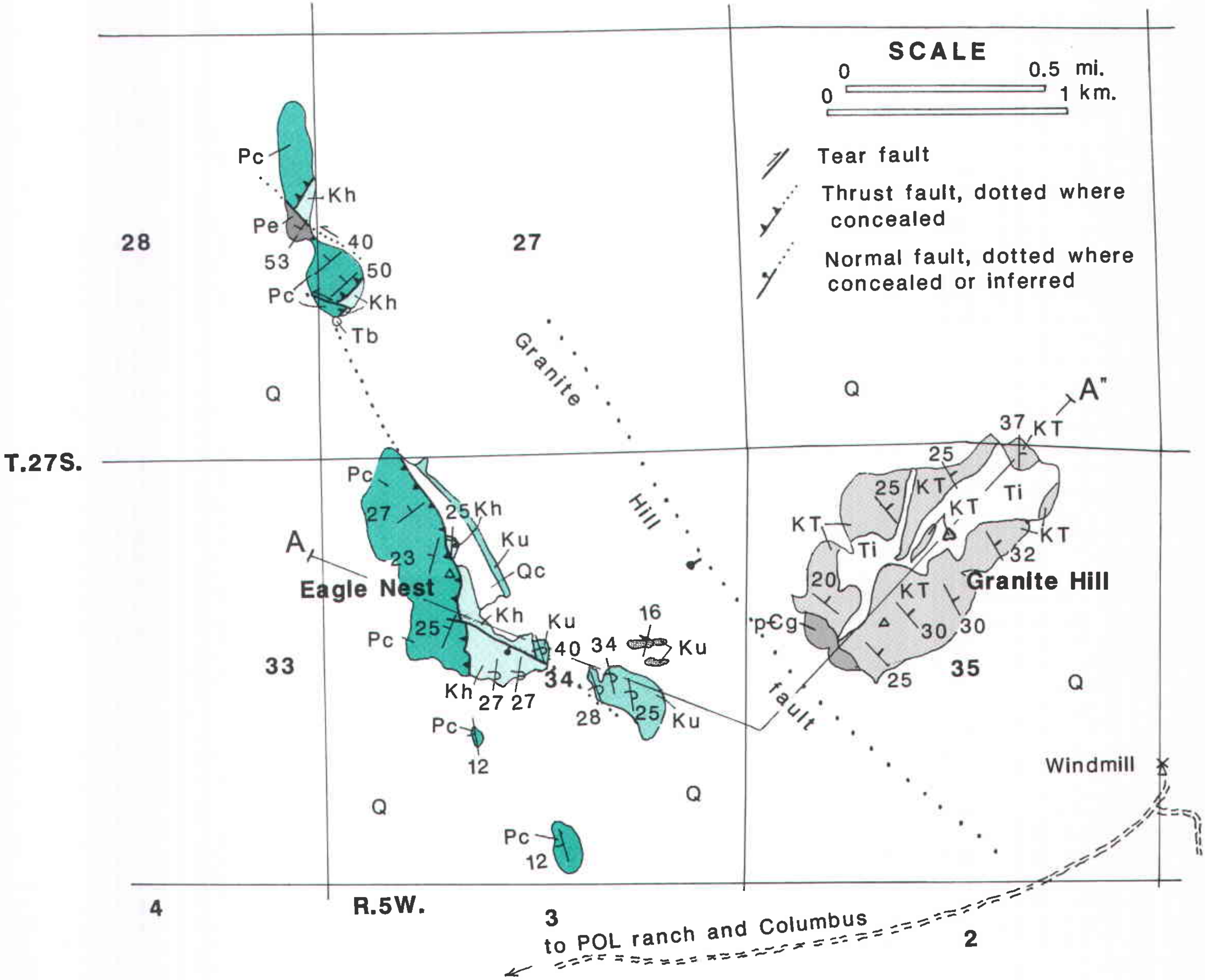

FIGURE 9—Geologic map of Eagle Nest–Granite Hill area. **p€g,** Precambrian granite; **Pc,** Permian Colina Formation; **Pe,** Permian Epitaph Formation; **Kh,** Lower Cretaceous Hell-to-Finish Formation; **Ku,** Lower Cretaceous U-Bar Formation; **KT,** Upper Cretaceous–lower Tertiary arkosic sedimentary rocks; **Ti,** Middle(?) Tertiary intermediate-composition intrusives; **Tb,** Tertiary basalt; **Q,** Quaternary sand and alluvium; **Qc,** colluvium.

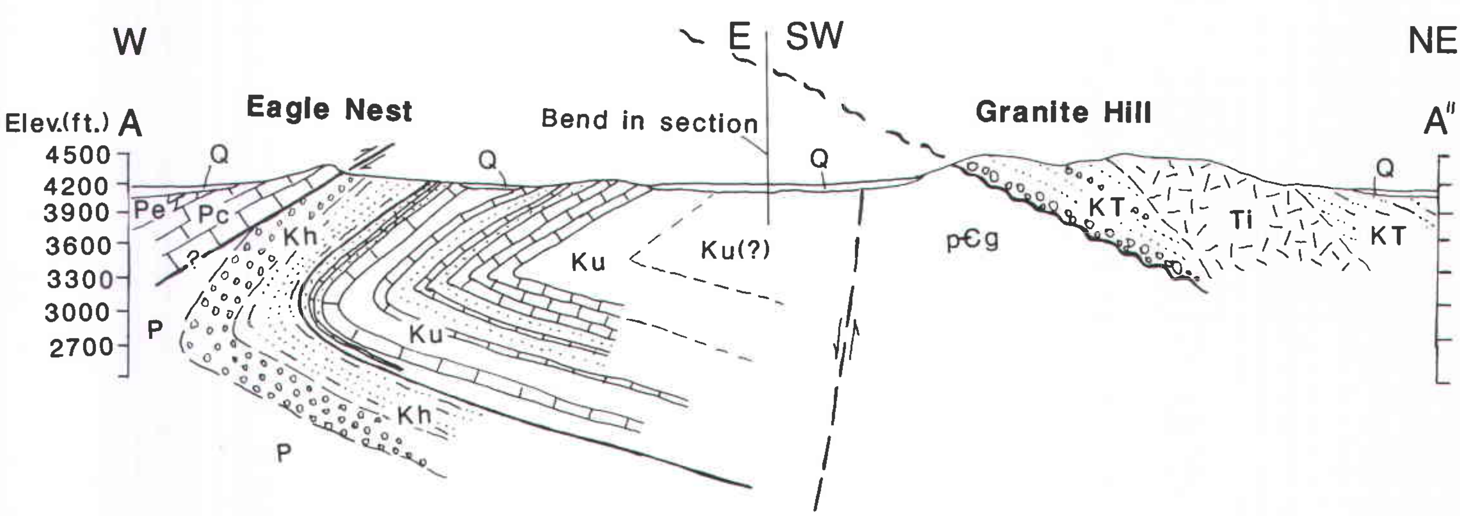

FIGURE 10—Geologic cross section through Eagle Nest and Granite Hill. See Fig. 9 for line of section. Symbols same as Fig. 9, except **P** indicates undifferentiated Permian or older rocks.

mation because these sediments contain little or no locally derived arkosic strata.

2) Uplift in Laramide time. Figure 10 shows that fault truncation of Lower Cretaceous strata is required by the structural relationships at Granite Hill and Eagle Nest. This truncation is therefore post-Early Cretaceous. The very coarse grained Upper Cretaceous to lower Tertiary arkosic strata at Granite Hill, derived from the underlying and adjacent granite, clearly indicate Laramide uplift and erosion of the Granite Hills block, presumably by movement along the fault in question. Of the three possible times of movement of the Granite Hills fault, Laramide movement seems best constrained by available evidence.

3) Late Tertiary movement. The site of Laramide uplift at Granite Hill eventually evolved into a Laramide basin as evidenced by the thick accumulation of upward-fining Laramide sediments. The basin is now uplifted and deeply eroded as a result of either renewed late Tertiary movement on the Granite Hills fault or uplift and eastward tilting of the Camel Mountain fault block, or both.

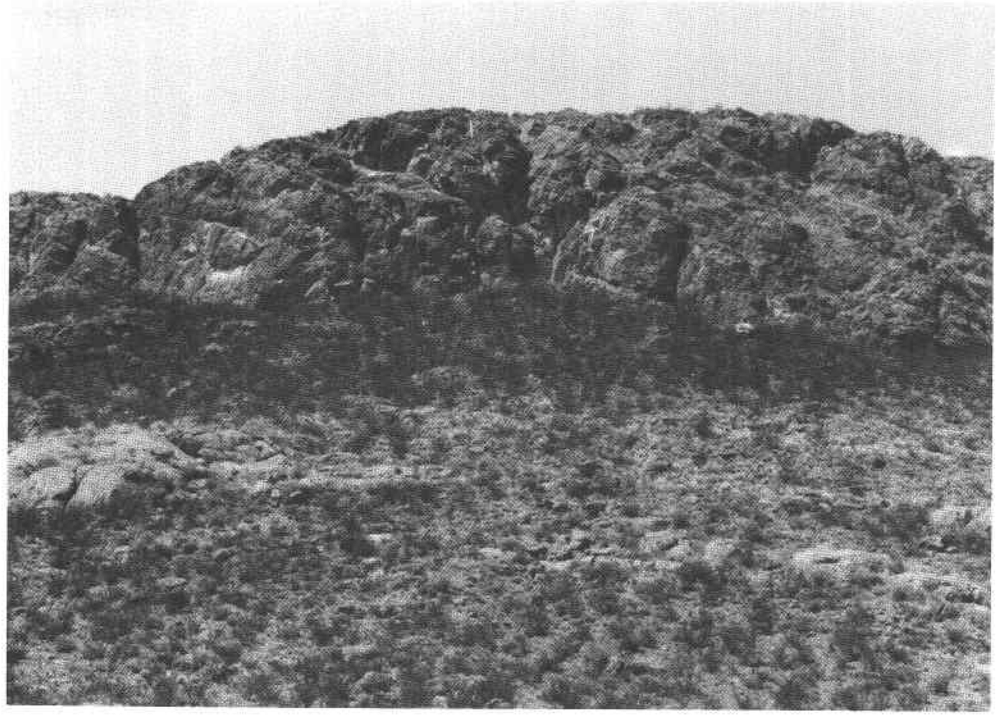

FIGURE 11—Permian Colina (uppermost Hueco) Formation in thrust sheet at Eagle Nest. Note truncation of bedding at thrust, which follows base of cliffs. Rudistid limestone member of U-Bar Formation forms outcrops in foreground and is overturned.

Conclusions

Although uncertainties remain concerning the geologic relationships between Granite Hill and Eagle Nest, several conclusions now seem clear. Lower Cretaceous rocks exposed at Eagle Nest can be correlated with the Hell-to-Finish and U-Bar Formations of the Little Hatchet and East Potrillo Mountains area. Approximately 288 m (945 ft) thick, these Lower Cretaceous strata form the overturned limb of a major syncline. Above the inverted Lower Cretaceous rocks, a thrust plate of Permian strata consists of carbonates that may be correlative with the Colina (uppermost Hueco) and Epitaph (Yeso) Formations; a thickness of approximately 240 m (787 ft) of Permian section is exposed in the thrust plate.

Thrust faulting at Eagle Nest was directed east–northeast and is Laramide in style. Total displacement is in doubt but may be significant.

At Granite Hill an upward-fining, right-side-up sequence of arkosic and conglomerate strata overlie Precambrian granite. At least 240 m (787 ft) thick, basal parts of the section were derived from the underlying granite whereas upper parts of the section represent distal-piedmont slope or basin-center facies. The section is probably uppermost Cretaceous to early Tertiary in age and most closely correlates with the Lobo Formation of the Florida Mountains area.

A major northwest-trending fault zone separates the contrasting styles of structure and stratigraphy at Eagle Nest and Granite Hill. Although the age and geometry of the fault is uncertain, uplift during the Laramide seems required to produce the coarse-grained arkose at the base of the Upper Cretaceous–early Tertiary (Lobo) section. However, the basement-cored uplift eventually evolved into a basin as indicated by the thick, younger, fine-grained parts of the arkosic Lobo section. Uplift during the Early Cretaceous and late Tertiary are other possible, but poorly constrained, times of fault movement.

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Upcoming geologic meetings

Conference title	Dates	Location	Contact for more information
Symposium on mineral resources of the Chihuahua Desert	Feb. 15–17	Univ. Texas El Paso El Paso, TX	Research Consortium of the Chihuahua Desert Dept. of Geol. Sciences Univ. Texas El Paso El Paso, TX 79968
Rockhound Round-up 1990	March 8–11	SWNM Fairgrounds Deming, NM	Deming Gem & Mineral Society Box 1459 Deming, NM 88030 (505) 546-6209
AAPG Southwest Section annual convention	March 11–13	Wichita Falls, TX	Dr. Robert L. McBroom, Sr. 1607 Singleton Wichita Falls, TX 76302-4009 (817) 766-6048
21st Annual Gem and Mineral Show	March 17–18	UNM Continuing Education Conference Center Albuquerque, NM	Albuquerque Gem and Mineral Club P.O. Box 13718 Albuquerque, NM 87192
New Mexico Geological Society annual spring meeting	April 6	Macey Center Socorro, NM	Neil H. Whitehead, III NMBMMR Socorro, NM 87801 (505) 835-5752

Open-file reports

NMBMMR

***358**—Geology of Winston 7½′ quadrangle, Sierra County, New Mexico, by R. W. Harrison, 17 pp., 2 reproducible map sheets. $6.40
***360**—Mineral resources of the Gray Ranch area, Hidalgo County, New Mexico, by S. Thompson III, R. W. Eveleth, and J. M. Barker, 1989, 48 pp. $9.60

USGS

87-568—Characteristics and trends of streamflow and dissolved solids in the upper Colorado River basin, Arizona, Colorado, New Mexico, Utah, and Wyoming, by T. D. Liebermann, D. K. Mueller, J. E. Kircher, and A. F. Choquette, 1989, 99 pp.
***88-490**—Variable-density ground-water flow and paleohydrology in the Waste Isolation Pilot Plant (WIPP) region, southeastern New Mexico, by P. B. Davies, 1989, 152 pp. $30.40
89-26—Conversion and comparison of the mathematical, three-dimensional, finite-difference, ground-water flow model to the modular, three-dimensional, finite-difference, ground-water flow model for the Tesuque aquifer system in northern New Mexico, by A. M. J. Umari and T. L. Szeliga, 1989, 39 pp.
***89-498**—Stratigraphic and sedimentologic studies of the Twowells Tongue of the Dakota Sandstone, southern San Juan Basin, New Mexico, by J. K. Dillinger, 1989, 29 pp. $5.80

USBM

Minerals yearbook 1987—v. II, area reports—domestic, 1989, 439 pp.

NMBMMR Mineral Museum Notes

Museum Fund

Amateur gem and mineral societies of New Mexico have recently established an endowment fund for the New Mexico Bureau of Mines and Mineral Resources Mineral Museum. Spearheaded by the Chaparral Rockhounds of Roswell and the Los Alamos Geological Society, the Bureau Museum Fund is designed to provide the museum with funds for the purchase of display-quality New Mexico mineral and gem specimens. Funds donated to the Bureau Museum Fund are invested through the New Mexico Tech Research Foundation at New Mexico Institute of Mining and Technology; the earnings will be used for specimen acquisition. All donations made to the Bureau Museum Fund, as well as those made directly to the museum, are tax deductible. The Bureau Museum Fund represents the first step in the Bureau's plans for remodeling and expanding the Mineral Museum.

Persons interested in making a tax-deductible donation to the Bureau Museum Fund should make checks payable to the New Mexico Tech Research Foundation, Bureau Museum Fund. Checks should be sent to the Alumni and Development Office, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801. For more information on the Bureau Museum Fund or other aspects of the Mineral Museum, contact the Bureau's Mineralogist and Curator, Marc L. Wilson, (505) 835-5246.

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