Tertiary-Quaternary sediments of the Rio Grande Valley in southern New Mexico

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known. For the most part, they are probably of late Miocene age but doubtless extend into the Pliocene. They are overlain and in part are interbedded with the gravels and conglomerates of the basin-filling Santa Fe group.

Basaltic lavas which are of several different ages represent the latest phase of igneous activity. Some are interbedded with gravels and conglomerates; some cap buttes and mesas as in the vicinity of Hachita, and some have spread over the floors of valleys as at Animas.

Volcanic rocks that underlie the great group of rhyolitic rocks noted above provide many more problems. The great bulk of these rocks is of intermediate composition and consists for the most part of gray or purplish andesitic or latitic breccias. Basaltic rocks doubtless occur with these rocks as do rhyolites. The rocks of this intermediate group are much less extensive in their distribution than the later rocks of the rhyolite group. In many places, they were removed by erosion before rocks of the rhyolitic group were extruded. They generally erode to rounded or mature slopes in contrast to the cliff slopes of the rhyolite group and may be partly covered by debris or by the later volcanics and basin-filling rocks. Of particular importance is the fact that in many places such as Silver City, Kingston, Tres Hermanas, Pyramid Mountains and other areas they are intruded by grani- ani- toid rocks, and are extensively altered and mineralized. In many of the intrusive areas these volcanics are converted to hornfels.

In some reports, such as the Silver City Folio, these intermediate rocks are designated as Upper Cretaceous. In the Little Hatchet Mountains and in the Pyramid Mountains, Lasky has called these rocks Lower Cretaceous. In other places they are regarded as Tertiary. In the Little Hatchet Mountains andesitic breccias are interbedded with Lower Cretaceous limestones and seem almost certainly to be of Lower Cretaceous age. Elsewhere these rocks lie upon other rocks such as the Upper Cretaceous sediments in the Silver City area, and are overlain by other volcanic rocks or by later conglomerates and gravels so that no exact dating is possible. By analogy with other regions it seems reasonable to regard these rocks as of Tertiary age. Some may be as late as Mid-Miocene, but some might be Oligocene or Eocene. It is hoped that the detailed mapping now under way in the southwest will permit sorting out the units of different ages in this group. Owing to the fact that these rocks are commonly the hosts of ore deposits, this study is of very real importance.

Intrusive igneous rocks have been worked out in great detail in the Santa Rita area and the reader is refered to the article on Santa Rita for a resume devoted in part to the intrusive sequence.

TERTIARY-QUATERNARY SEDIMENTS OF THE RIO GRANDE VALLEY IN SOUTHERN NEW MEXICO

by
Frank E. Kottlowski

Cenozoic sediments in southern New Mexico are extensively confluent with the Cenozoic volcanic rocks as the sediments are interbedded with and are in large part derived from volcanic series. As exposed and preserved near the Rio Grande Valley, the Cenozoic sediments are divisible into five broad units: (I) conglomerate, red sandstone, red clay, and gypsum unconformable on strata from Precambrian to Cretaceous in age, interbedded or interlensing with latitic, andesitic, and purplish rhyolitic volcanics; (II) arkosic, pumiceous, and tuffaceous sandstones interbedded with rhyolite welded tuff, and beneath the Uvas* basaltic andesite; (III) lower conglomerates and pebbly sandstones of Santa Fe group**; (IV) upper varicolored unit of Santa Fe group which contains a Pliocene fauna; (V) the uppermost bolson and valley fill sediments, contains many Pleistocene vertebrate fossils, and includes river sands and gravels, eolian sands, playa silts, local pediment gravels, lake clays, and three series of basaltic volcanics. The above units are covered in many places by Recent alluvium and in places are difficult to differentiate from their own debris.

Near El Paso the late Cenozoic sediments consist of two series equivalent to units IV and V above. A thin mantle of Pleistocene and Recent fluvial sand and gravel, eolian sand, and lacustrine clay, cemented in part by caliche, caps La Mesa west of Mesilla Valley and the surface of the Hueco bolson northeast

*Manuscript name.

**Manuscript report of Santa Fe Area proposed the Santa Fe formation be raised to group status, upper Miocene to Pleistocene age (Baldwin, Kottlowski, and Spiegel).

of El Paso. These unconsolidated beds have yielded numerous Pleistocene vertebrates (Sayre and Livingston, 1945, p. 37) and exceed 60 feet in thickness only near the mountains where alluvial fans are thick. The main bulk of the bolson deposits near El Paso are probably of Pliocene age, although the Tertiary – Quaternary contact is difficult to distinguish. The Pliocene sediments are tan, pale reddish-brown, light gray, and buff silt, clay, sand, and pebbly calcareous sandstone, and are similar to strata typical of the Santa Fe group near Santa Fe. Four criteria differentiate the Pliocene rocks from more recent deposits: (1) beds are at least partly cemented and contain many calcareous sandstone nodules, (2) beds in places are tilted and faulted, (3) sediments are finer-grained than overlying Quaternary deposits, (4) the rocks, taken as a unit, are more brilliantly colored. Near La Union, New Mexico, the older bolson sediments contain fragments of Pliocene vertebrates.

The Cenozoic sediments are at least 1500 feet thick near Fort Bliss, Texas, are more than 1330 feet thick northwest of Cerro del Muleros, and are 86 feet thick (probably all late Pleistocene) in the gorge above El Paso (Sayre and Livingston, 1945, p. 33-35).

Along the east side of Mesilla Valley, the Pliocene beds are covered and obscured by Pleistocene and Recent sediments which include much coarse gravel derived from the Franklin and Organ mountains and eolian sand blown from the valley floor. Along the west side of Mesilla Valley, the Pliocene sediments are well exposed in the scarp at the edge of La Mesa. In the badlands between the scarp and the valley, the Pliocene beds are covered in most places by slope wash, eolian sand, fluvial sands, and terrace gravels. The Pleistocene deposits thicken north of Chamberino so that rocks of unit IV are not again exposed until Picacho Peak, 21 miles to the north, near Las Cruces.

Numerous basalt flows and cones dot La Mesa. These basic eruptives are probably of three stages: (1) Basalts such as exposed in Kilbourne Crater (22 miles west of Vinton) which are characterized by large black pyroxene crystals and aggregates of olivine. These basalts are partly buried beneath eolian sands, fluviatile sandstones, and caliche gravels. (2) Basalts such as the San Miguel flow which is erupted on the Picacho terrace (170 to 200 feet below La Mesa surface), and is partly buried on the windward slopes by sand dunes. (3) Fresh-appearing basalts such as at the Aden volcano and associated cinder cones (25 miles west of Berino).

Tertiary rocks in the Organ Mountains were mapped by Dunham (1935) as follows: (1) A basal conglomerate of limestone boulders resting unconformably on Hueco limestone. (2) Basal tuff, latitic to rhyolitic, 135 feet thick. (3) Orejon andesite flows, tuffs, and dikes, about 600 feet thick. (4) Cueva rhyolite tuffs and flows, 120 to 250 feet thick. (5) Soledad rhyolite welded tuff, more than 2500 feet thick. (6) Santa Fe beds, equivalent to unit III.

Near Las Cruces, cropping out along the Rio Grande Valley, and in the Dona Ana, Robledo, and Picacho mountains, the Cenozoic beds can be divided into 12 units: (1) Interbedded reddish clay, gypsum, and latitic breccia-tuffs (Unit I), 330 feet thick, unconformable on San Andres (?) limestone. (2) Purple, gray, and green latitic tuffs, and breccia-tuffs, more than 1630 feet thick; in the Dona Ana Mountains the softer volcanics interfinger with massive latite-andesite breccias and flows. (3) Massive purple and pale reddish-brown welded rhyolite tuffs, more than 1220 feet thick. (4) Monzonitic intrusives associated with mineralization. (5) Bell Top* formation, which consists of pumice, soft pinkish rhyolite tuffs, vitrophyre flows and dikes, banded rhyolite flows and domes interbedded with light-colored pumiceous and tuffaceous sand and sandstone, and a few lenses of stream gravel (Unit II), more than 800 feet thick. (6) Flows of Uvas basalt/basaltic andesite with interbedded scoria and basaltic tuffs, as much as 145 feet thick. (7) Lower part of Santa Fe group (Unit III); conglomeratic sandstone, sands, and silts colored pink, light gray, and yellow with many calcareous sandstone concretions; more than 115 feet thick. (8) Upper part of Santa Fe group (Unit IV); interbedded light-gray sandstone, sand, and pinkish silt intertonguing with a thick sheet of boulder conglomerate east of Robledo Mountain; overlain by light gray sands and brown clayey silts; more than 560 feet thick. (9) Light gray and light brown sands, silts, and gravels, bearing Pleistocene fossils; caliche cemented in beds close to La Mesa and Jornada surfaces; more than 350 feet thick. (10) Basalt flows and necks similar to Kilbourne basalt. (11) River gravels and sands unconformable on La Mesa and Jornada sediments, and associated with Picacho terrace. (12) Late Pleistocene and Recent valley fill, alluvium, eolian sands, and playa silts (9 to 11 is unit V).

*Manuscript name.

There are two extensive surfaces above the floodplain near Las Cruces. The La Mesa surface to the west is 300 or 500 feet above the valley floor. The two levels are separated by a fault that strikes south from Picacho Peak. The contiguous Jornada surface to the east is about 390 feet above the Rio's floodplain, with the Mesilla Valley a wide trough cut below the La Mesa – Jornada surface. Along both sides of the valley, although chiefly along the west side, the Picacho terrace has been carved 100 to 150 feet above the river.

The Cenozoic deposits in and near Selden Canyon, Selden Hills, and Tonuco Mountain (San Diego Mountain) are similar to those near Las Cruces except: (a) The gypsum of unit I is absent. (b) Unit 3, the massive purple welded rhyolite tuff, is largely a pinkish rhyolite breccia. (c) The Palm Park formation (Unit I equivalent) appears, composed of detritus from units 1-3 and interbedded with lenses of these volcanic pyroclastics; the Palm Park formation is more than 655 feet thick on Tonuco Mountain but pinches out abruptly to the south. (d) Light-colored tuffaceous conglomeratic sandstone about 210 feet thick is the correlative of unit 5 but to the north near the Caballo Mountains it thickens and is called the Thurman formation (Unit II). (e) Uvas basalt is absent north and east of Selden Canyon but pebbles and boulders derived from it are abundant in the younger clastic beds. (f) Lower Santa Fe group (Unit III) rests unconformably on Palm Park, Thurman, and volcanic rocks; near Tonuco it consists of a basal, hard, reddish-brown conglomerate and conglomeratic sandstone composed mostly of volcanic debris, as much as 950 feet thick; a middle series of yellow-brown conglomerate sandstone 375 feet thick including a medial lens of light-gray tuffaceous sand about 95 feet thick; an upper series of tan and pinkish sandstones and sands with interbedded siltstone, totaling more than 375 feet thick. To the south and west tha basal red conglomerate pinches out, and the middle yellow-brown sandstone beds thin, but the upper tan and pink beds thicken so that west of Selden Hills they are more than 1300 feet thick. (g) Near the south end of Selden Canyon an olivine basalt, the Selden* basalt tongue, is interbedded with the basal beds of the Santa Fe group. (h) Upper Santa Fe group (Unit IV) beds are alternating lenses of pink and whitish sands, sandstones, siltstones, and sandy clays containing calcareous sandstone concretions and teeth fragments of Pliocene vertebrates; unit more than 290 feet thick.

* Manuscript name.

Near Hatch and in the northern foothills of Sierra de las Uvas, the Bell Top formation is the oldest rock exposed, and it intertongues to the northeast with the Thurman formation in the Rincon Hills and at Palm Park. The Uvas basalt caps the Bell Top formation southwest of Hatch, but near Palm Park similar flows are interbedded with the upper strata of the Thurman formation. The Santa Fe beds (Units III & IV) and the overlying thin mantle of Pleistocene sediments (Unit V) that crop out along the Rio Grande Valley from Hatch to Truth or Consequences are similar to rocks of Units III & IV near Tonuco Mountain.

The Cenozoic sediments in the foothills of the Caballo Mountains were studied by Kelley and Silver (1952, p. 113-129) and were mapped by William D. Tipton (manuscript map). The basal beds are the Palm Park formation which overlies unconformably rocks from Precambrian to Cretaceous in age. The formation is characterized by a reddish-brown, purple, or light blue-gray coloration, and by the included latitic to andesitic debris. A generalized section along Apache Creek, east of Caballo Dam, from the base upward is: (a) reddish-brown interbedded silt and coarse conglomerate, 300 feet thick; (b) light blue-gray to purple porphyritic latitic tuff, 300 feet thick; (c) pinkish tuffaceous sandstone, 200 feet thick; (d) whitish algal limestone, 10 feet thick; (e) pinkish, tuffaceous, pebbly sandstone, sand, silt, and clay, 55 feet thick; (f) whitish to light-gray brown algal limestone 5 to 20 feet thick, very lenticular; (g) pink to red-brown tuffaceous sand, 15 feet thick; total thickness about 885 feet.

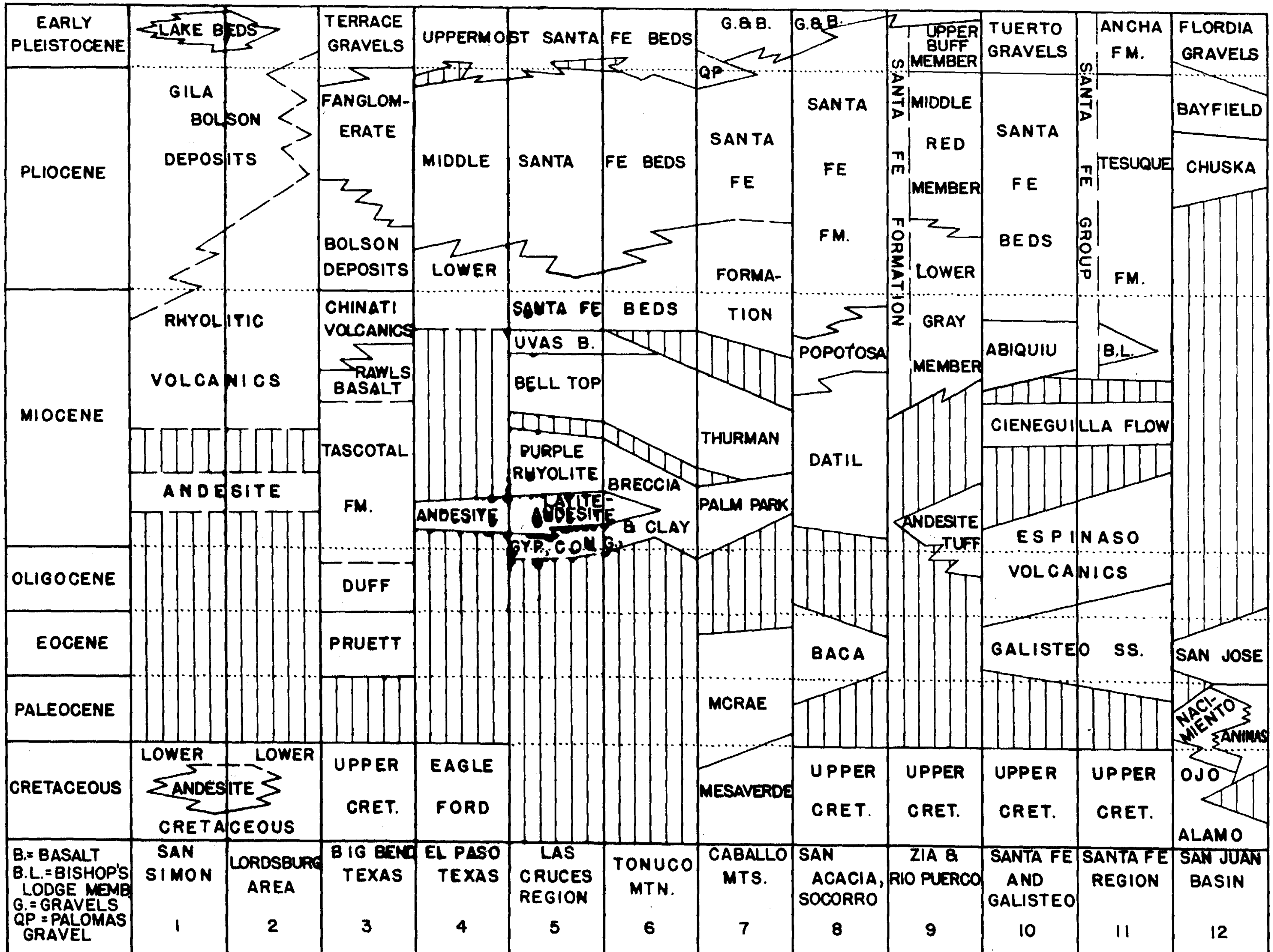
The Thurman formation overlies the Palm Park formation, and is composed chiefly of white to light buff tuff, tuffaceous sandstone, and sandy clay, with interbedded rhyolite breccia-tuff and basalt. Near Palm Park a generalized section from base upward consists of: (a) soft whitish crystal tuff and tuffaceous sandstone, 2 to 50 feet thick; (b) resistant light brown rhyolite welded breccia-tuff, 60 feet thick; (c) white to tan bedded tuff, tuffaceous sandstone, conglomeratic sandstone, and pink silty clay, about 1100 (bedding plane faults?) feet thick; (d) local basalt flow, megascopically similar to the Uvas basalt, 20 feet thick; (e) light gray and pink tuffaceous and conglomeratic sandstone, and white bedded tuff, approximately 325 feet thick; total thickness about 1550 feet, although beds may be absent or repeated along strike faults. The Santa Fe beds are unconformable on the Thurman formation and are similar to outcrops near Hatch. West of the Rio Grande Valley, toward the Animas Hills, and on the slopes of the Sierra de las Uvas, a thin to thick gravelly deposit truncates the Santa Fe strata, and has been called the Palomas gravel (Harley, 1934, p. 211).

The oldest Cenozoic sediments along the Rio Grande Valley south of Truth or Consequences are either lacustrine clays and gypsum or coarse clastics interbedded with or partly derived from volcanics. They may be Cretaceous to Miocene in age but appear similar to Miocene rocks in other parts of New Mexico (see chart). The sediments of unit II seem to correlate with fluvial and lacustrine tuffaceous rocks near Hillsboro which contain Miocene (?) plant fossils. Unit III, the basal indurated beds of the Santa Fe group, are correlated by stratigraphic position with upper Miocene – lower Pliocene strata elsewhere. Unit IV, the varicolored sandstones and sands of the Santa Fe group, contain Pliocene fossils, and unit V has yielded many Pleistocene vertebrate remains. Units I and II are merely contemporanous by-products of Miocene vulcanism. Units III and IV are alluvial fan, bajada, and playa sediments, deposited in a series of bolsons along the complex structural depression, the Rio Grande graben. Probably there was no pre-Pleistocene Rio Grande because rocks similar to the Santa Fe beds occur as bolson fill in structural grabens throughout the Basin and Range province of southwestern New Mexico, southeastern Arizona, and northern Mexico.

Cascadian deformation, chiefly block faulting and tilting, was probably only a continuation of like movements that have occurred in the area from mid-Miocene to Recent. Most likely the important change from Tertiary to Quaternary was one of climate, associated with the epeirogenic doming of the San Juan Mountains area in southern Colorado and northern New Mexico. Increase in precipitation (whether or not concurrent with Pleistocene glaciation), in addition to the rise of a headwater highlands, probably initiated the Rio Grande. Beginning as slope runoff, floods, and short-lived lakes in southern Colorado and northern New Mexico, the waters overflowed from bolson to bolson, alined along the present structural depression, until a through stream was developed. This early Pleistocene Rio Grande meandered across wide valleys from the San Luis Valley down to La Mesa area to evaporate in the playa region of Mexico, southwest of El Paso. The upper Rio Grande drainage probably was captured in mid-Pleistocene time by the headward erosion of the lower (Texas-Mexico) Rio Grande which was tributary to the Gulf of Mexico. Once captured, the upper part of the stream trenched wide valleys into the bolson fill (such as Mesilla Valley) and cut narrow gorges where superimposed on hard bedrock (El Paso). There probably were four periods of cutting and filling parallel to the four glacial and interglacial stages, but indications of only two epochs of degradation and aggradation are preserved near Las Cruces. Denny (1941) has mapped four surfaces near San Acacia.

Suggested correlations of Cenozoic rocks along the Rio Grande in southern New Mexico and in adjoining areas are given on the accompanying chart. Sources of information for the twelve columns are:

1. San Simon: Schwennesen, 1917; Meinzer and Kelton, 1913.
2. Lordsburg: Schwennesen, 1928; Lasky, 1938.
3. Big Bend: Moon, 1953; Skees, 1953; Rix, 1953.
4. El Paso: Sayre and Livingston, 1945; Nelson, 1950; Strain, 1950.
5. Las Cruces: FEK.
6. Tonuco: FEK.
7. Caballo: Kelley and Silver, 1952; Tipton (personal communication); FEK.
8. San Acacia and Socorro: Denny, 1941, 1940; Wilpolt and Wanek, 1952.
9. Zia: Bryan and McCann, 1937.
10. Galisteo: Stearns, 1953.
11. Santa Fe Region: Baldwin, Kottlowski, and Spiegel (manuscript report).
12. San Juan Basin: Kelley and Silver, 1952; J. E. Allen (personal communication).



CORRELATION CHART OF CENOZOIC ROCKS ALONG RIO GRANDE