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FACETS OF THE LATE PALEOZOIC STRATA IN SOUTHWESTERN NEW MEXICO

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Where now the blistering summer sun sends waves of heat over the desert sands, once rolled cool salty waters of late Paleozoic seas. But there were islands in these seas. Limy beds deposited in some places were torn up along emerging shorelines. Far to the north (and south?) ridges and ranges were worn down to provide detritus that washed into these widespread seas as arenaceous sands and clays.

Once the Middle Mississippian crinoidal limestones blanketed southwestern New Mexico, extending beyond Socorro, eastward over where now the Sacramentos and Sierra Blanca tower, and northwestward beyond Mogollon where volcanic rocks now hide the pre-Tertiary strata.

During the last moments of the Mississippian, a karsted landscape drained southward to shallow Chesterian seas. The northern sea coast may have oscillated somewhere near a line drawn from Lordsburg to Alamogordo. Southward, in nearshore waters, were deposited the arenaceous, fossiliferous calcarenites of the Helms Formation to the east and the Paradise Formation to the west.

The lithic section above Middle Mississippian strata is somewhat similar if examined in the Black Range or to the south in the Franklin Mountains. The Middle Mississippian limestones are overlain by nearshore arenaceous calcarenites and shaly beds, succeeded by thick-bedded fossiliferous marine limestones. In the Franklins, the nearshore deposits are the Late Mississippian Helms strata overlain by massive Morrowan limestones, whereas in the Black Range the basal nearshore sediments are of Atokan (Derryan) age and the overlying thick-bedded limestones are of Desmoinesian age.

Thus during Late Mississippian time the northern part of southwestern New Mexico was exposed to erosion while the southern margin received nearshore sediments of the regressive Helms-Paradise sea. During earliest Pennsylvanian, Morrowan time, marine limestones were deposited to the south while the northern part lay just above sea level. Atokan time was marked by northward transgression. Detritus was derived from the pre-Atokan erosional surface, local islands, and upland to the north and northeast.

During Desmoinesian time most of the state was covered by shallow marine waters. The thin Desmoinesian shales and sandstone lenses were sea-washed detritus from the Pedernal upland to the northeast and the Zuni upland to the northwest. These landmasses and the local Florida islands of west-central Luna County shed more debris during Missourian time and by Virgilian time large quantities of clay and feldspathic sand were being moved into the late Pennsylvanian seas, mainly from the Pedernal upland.

Thick sequences of interbedded clastics and limestones accumulated in the zeugogeosynclinal Orogrande basin (in western Otero and eastern Dona Ana Counties) during the late Pennsylvanian. In the autogeosynclinal Pedregosa basin of southern Hidalgo County the deposits were marine limestone.

Deposition of marine limestone, with local reefs and intrabasinal black shales, continued in the Pedregosa basin during Early Permian, Wolfcampian time. Meanwhile to the east, the interbedded marine limestone and shale of the Hueco Formation overlapped the edges of the Orogrande basin, and intertongued northward with southward thinning sheets of Abo red beds. Transition beds between the Pennsylvanian and Permian are the intercalated limestones and red beds of the central New Mexico Bursum Formation as shown by the transitional *Schwagerina-Triticites* fusulinid fauna.

The Abo or Hueco is the youngest Paleozoic unit now present throughout much of southwestern New Mexico, but this is due to the erosion of younger Paleozoic rocks during early and middle Mesozoic time, not owing to nondeposition. These younger (Leonardian and Guadalupian) units are the Yeso, locally the Glorieta, and San Andres formations to the northeast, and the Colina, Epitaph, Scherrer, and Concha formations of Hidalgo County and southeastern Arizona.

PREVIOUS WORK

This general outline of late Paleozoic history is a part of the printed record. What is newly known, or unique to the southwest?

In 1951, the late Paleozoic strata in southwestern New Mexico were grouped in Darton's (1928) Gym limestone, a term that should be abandoned as suggested by Bogart (1953) and Kelley and Bogart

(1952), or in the Silver City area into the Oswaldo (below) and Syrena (above) Formations of Pennsylvanian age, and the Abo red beds. Near Las Cruces, Dunham (1935) mapped the ambiguous Magdalena Formation, Hueco Limestone, Abo sandstone, and Chupadera formation. And the Lobo red beds became fixed in the geologic literature as an all inclusive term for reddish strata that occur at various stratigraphic positions in Luna County.

During the last 15 years, a sizable volume of geologic reports has been complied on the late Paleozoic of this region. Some of the more comprehensive areal studies (including area to the east) are of the Sacramento (Pray, 1961; Otte, 1959), Caballo (Kelley and Silver, 1952), San Andres (Kottlowski et al., 1956; Kottlowski, 1959), Franklin (Harbour, 1958, 1960), Robledo (Kottlowski, 1960a), Tres Hermanas (Balk, 1961, Kottlowski and Foster, 1962), Victorio (Griswold, 1961), Peloncillo (Gillerman, 1958), Chiricahua (Sabins, 1957), Pedregosa (Epis, 1956), and Big Hatchet (Zeller, 1965) Mountains, central Black Range (Kuellmer, 1954), and Cooks Peak (Jicha, 1954; Elston, 1957). Regional stratigraphic reports of discrete units are those of the Mississippian (Laudon and Bowsher, 1949; Armstrong, 1962) and Pennsylvanian (Kottlowski, 1960b, 1960c), as well as a summary of the Paleozoic and Mesozoic rocks (Kottlowski, 1963). Several oil tests drilled during the last decade have helped (or confused) interpretation of the Paleozoic record.

BASAL CONTACT

When the Pennsylvanian and Permian strata are considered as the late Paleozoic deposits of New Mexico, one immediate and continuing problem is their basal contact. Zeller (1965) and others working in Hidalgo County have some difficulty placing the lithic and faunal boundary between the Late Mississippian Paradise Formation and shaly clastic basal beds of the overlying Horquilla Formation. In the northern Franklin Mountains and on Bishop Cap, there is no problem if one uses fossils, but the lithologies are deceptive. In these mountains the basal Pennsylvanian is massive cherty limestone unconformable on the underlying shaly Helms Formation. The Helms can be confused with shaly beds that occur elsewhere at the base of the Pennsylvanian.

Near Silver City, chert and shale of the basal Pennsylvanian Oswaldo Formation overlie cherty crinoidal Lake Valley-Kelly limestones, giving both a sharp lithic and faunal contact, which is also typical of the sequences in the Black Range, Sierra Cuchillo, and San Andres Mountains.

Erosion during several intervals of middle and late Paleozoic time has complicated the stratigraphic record along the Rio Grande Valley region, suggesting in part that this Cenozoic structural depression may be related to some deep-seated structural zone antedating its present structural and topographic expression.

To the south in the Robledo Mountains, the thin Atokan sequence along the Rio Grande probably rests on the Early Mississippian Caballero Formation (complications of intrusive sills prevent an exact determination). Twenty-five miles to the east-northeast in the southern San Andres Mountains, basal Pennsylvanian strata overlie Middle and Late Mississippian rocks. In the southern Caballo Mountains (Kelley and Silver, 1952), thin remnants of the Lake Valley Limestone occur beneath the Pennsylvanian whereas in the northern part of the range and in the Mud Springs Mountains, the Pennsylvanian rests on Devonian strata.

East of the Caballo Mountains in the San Andres Mountains and in the Sunray Mid-Continent No. 1-M Federal oil test, drilled on Jornada del Muerto in sec. 23, T. 15 S., R. 2 W. about 30 miles north-northeast of Hatch, as well as to the west of the Caballos in Sierra Cuchillo, the Middle Mississippian Lake Valley Limestone is relatively thick beneath the Pennsylvanian.

In the Fra Cristobal Mountains, north of the Caballos, Pennsylvanian beds rest on the Ordovician El Paso Limestone, Cambrian-Ordovician Bliss Sandstone, and Precambrian rocks, in order northward (Kelley and Silver, 1952), whereas to the northeast in the Sun Oil No. 1 Victorio oil test (sec. 33, T. 10 S., R. 1 W.), the Pennsylvanian shales overlie the upper Ordovician Montoya Dolomite.

Thus, in a north-south area extending southward from the Fra Cristobal Mountains to the Robledo Mountains, erosion during late Mississippian and early Pennsylvanian time removed more pre-Pennsylvanian rocks than from areas to the east and west, suggesting a low north-trending arch, the "Cristobal-Caballo" arch which perhaps formed a narrow chain of shoals, in the early Pennsylvanian seas.

One of the widespread erosion surfaces of the Paleozoic was developed during the late Silurian, Early Devonian, and Middle Devonian time. In most places this truncating surface developed on the Silurian Fusselman Dolomite. Much of the southward thickening of the Fusselman is due to northward erosion. Near the New Mexico-Arizona line, Devonian clastics overstep westward the Fusselman and the various Ordovician units. The abrupt change from the pre-Devonian car-

bonate rocks to the shaly and silty Devonian strata emphasizes this erosion surface.

In the Fra Cristobal Mountains and in nearby oil tests, some of the unfossiliferous greenish silty shales at the base of the Pennsylvanian have a Devonian aspect. This suggests that the "Cristobal-Caballo" arch, covered by a thin remnant of Devonian shales, may have been a positive feature just prior to Late Devonian time.

In the northeastern part of southwestern New Mexico, basal Pennsylvania beds rest on the Precambrian in the southern Oscura Mountains in sec. 12, T. 8 S., R. 5 E. (Bachman, 1961), just north of the eroded wedge-edge of the Bliss Sandstone. On the west side of the "Cristobal-Caballo" arch, the eroded wedge-edge of pre-Pennsylvanian lower Paleozoic strata probably extends farther north, although the northernmost outcrop is in secs. 15-16, T. 8 S., R. 4 W. amid fault blocks southwest of Eaton Ranch (Kelley and Furlow, 1965), a locality about half a mile south of the latitude of the southern Oscura Bliss outcrops.

At the Eaton Ranch locality, Atokan beds overlie poorly exposed, steeply dipping, partly recrystallized beds that consist of, in descending order, about 20 feet of the Upham Dolomite, 10 feet of Cable Canyon dolomitic sandstone, about 95 feet of lower El Paso Limestone, and perhaps 95 feet of Bliss Sandstone. This significant pre-Pennsylvanian section was erroneously mapped by the writer as lower Pennsylvanian strata. Apparently some geologists can be so obsessed in looking for Pennsylvanian rocks that other possibilities can be ignored! Beds of oolitic hematite were thought to resemble the Bliss hematite, but fragments of brachiopods were mistakenly identified as of early Pennsylvanian age.

Kelley and Furlow (1965) recognized the true identity of these pre-Pennsylvanian beds, but did not find identifiable fossils. Rousseau H. Flower and Roy W. Foster in May, 1965 found a few pieces of brachiopods and trilobites that verified identification of the Bliss and El Paso. The Montoya is so recrystallized that only crinoid columnals were recognizable. The more than 200 feet of pre-Pennsylvanian rocks at this locality suggests that such early Paleozoic strata may be found much farther to the northwest, in the Datil-Mogollon volcanic area, than had previously been thought.

A similar "fenster" of Paleozoic rocks occurs near Peñasco Spring in the southeastern foothills of the San Mateo Mountains, about 3½ miles west of U.S. Highway 85. Although long known to ranchers, one of the first geologists to look at these outcrops in some detail was Steve Farkas, a University of New Mexico graduate student. Most of the Paleozoic outcrops are in sec. 13, T. 10 S., R. 5 W., about 1000 feet southwest of Peñasco Spring, and occupy a west-northwest-trending strip about 1½ miles long and ½ mile wide. A whitish, latitic tuff unconformably overlies the limestones on the northeast. The southwest boundary is a fault zone against different latites.

Generally, the limestones dip 5 to 10 degrees to the northeast and are about 500 feet thick, in part brecciated and silicified, and are cut by faults. A few feet of Yeso pinkish siltstone and silty limestone, overlain by Glorieta-like yellowish-gray sandstone, crops out along the south-bounding fault zone at the base of the exposures. Most of the section is a dark-gray, partly recrystallized limestone and dolomitic limestone, with scattered calcite-filled vugs, and numerous gastropods, algal fragments, and brachiopods and resembles the San Andres Limestone. Some of the fault blocks may be of Pennsylvanian limestone, but no fusulinids were found, chert is rare, and no shale interbeds were seen. A fairly thick sequence of upper Paleozoic strata may occur in the subsurface, overlying probable Ordovician units.

UPPER CONTACT

Although the base of the late Paleozoic sequence is a problem in some localities, the top can be easily identified. This upper contact is in most places a surface produced by one or more erosional unconformities. The most important unconformities developed during (1) early and middle Mesozoic time, and (2) during early Tertiary time.

The sections at the Eaton Ranch and Peñasco Spring localities are examples of uneven erosion during early Tertiary time. Paleozoic strata were apparently tilted and faulted during "the Laramide" orogency, and, after erosion during early Tertiary time, Datil-like volcanic rocks of probable early Oligocene age were intruded through and extruded upon Precambrian granite, Pennsylvanian beds, Abo red beds, and the Yeso and San Andres Formations within an area 5 to 20 miles wide.

These relationships are typical in the northern Black Range and southern San Mateo Mountains area. East of the Rio Grande in the Fra Cristobal, Caballo, and San Andres Mountains in general, and in oil tests drilled on Jornada del Muerto, a thinned San Andres Limestone underlies the Late Cretaceous Dakota Sandstone. In the Franklin Mountains, Early Cretaceous strata overlie the Hueco Formation, whereas in the southernmost San Andres Mountains a northward-thinning feather-edge of the Lower Cretaceous is unconformable on a thin, eroded San Andres Limestone.

In the Robledo and Organ Mountains, Tertiary conglomerates, red silts, gypsum, and andesite breccia (Oligocene in age?) overlie the Hueco Formation. In this area, both the post-Hueco Paleozoic strata and the Cretaceous beds were removed by erosion during early Tertiary time.

Near Emory Pass and Kingston in the Black Range, Tertiary andesites and conglomerates in most places rest unconformably on either Abo red beds or on upper Pennsylvanian limestones. Locally, the red beds are overlain by a light-gray conglomeratic sandstone and black shale which may be remnants of Cretaceous strata. Near Lake Valley, the Tertiary Rubio Peak Andesite-Latite is unconformable on the Lake Valley Limestone, but about ten miles to the southwest on the flanks of Cooks Peak, the slightly older Tertiary-(?) Macho Andesite overlies the Late Cretaceous Colorado Formation (a Mancos equivalent). Around Cooks Peak, the Early Cretaceous Sarten Sandstone is unconformable on the Abo red beds, although Jicha (1954) and others have referred these red beds to the enigmatic Lobo formation.

Whatever the type Lobo is in the Florida Mountains, the so-called Lobo of the Cooks Range is the same unit as the Abo red beds 20 miles to the north in the Black Range and the Abo of the Santa Rita area 20 miles to the northwest.

The Abo red beds near Santa Rita and Cooks Peak do contain more coarse-grained clastic fragments than the Abo of the central Black Range. Near Santa Rita, the Abo Formation is 50 to 210 feet thick, is overstepped westward and southwestward by the basal Cretaceous Beartooth Quartzite, and consists of intertongued limestone-pebble conglomerate, red shale, and argillaceous algal limestone with some lenses of chert conglomerate and arenaceous red shale-siltstone (Spencer and Paige, 1935). On Cooks Peak, the Sarten Sandstone is unconformable on the Abo red beds, which are 80 to 375 feet thick and consist of lower limestone-chert conglomerates and upper reddish-brown arenaceous shale and silty sandstone.

The Beartooth Quartzite unconformably overlies the Abo red beds southeast of Santa Rita, the Syrena Formation (Upper Pennsylvanian) northeast of Central along New Mexico Highway 90, the Oswaldo Formation (Lower Pennsylvanian) on most of Lone Mountain, westward-thinning (due to pre-Beartooth erosion) Pennsylvanian-Mississippian-Devonian strata in the Silver City Range west of Silver City, and on Precambrian rocks in the Little Burro Mountains southwest of Silver City. The Burro Mountains region was the northwest flank of the Burro uplift, a positive-tending paleogeographic feature that was subjected to erosion during early and middle Mesozoic time.

To the south in the Victorio Mountains about 15 miles west of Deming, fossiliferous Early Cretaceous limestone, chert conglomerate, and sandstone are unconformable over the Ordovician Montoya Dolomite and the Silurian Fusselman Dolomite; twelve miles farther south in the central Cedar Mountains, Cretaceous conglomerates overlie Mississippian and Pennsylvanian strata. These relationships mark the southern margin of the Mesozoic-age Burro uplift.

All of the pre-Pennsylvanian Paleozoic strata appear to have been deposited over the site of the Burro uplift (Elston, 1958). A forerunner of the Burro uplift, the Florida islands, was a positive-tending paleogeographic feature during Pennsylvanian and early Permian time that rose in central and northwestern Luna County. This low quasi-uplift is documented by the thin, clastic section of middle Pennsylvanian sequence in the Tres Hermanas Mountains; the Hueco Formation clastics and limestones unconformable on lower Mississippian limestone (Pennsylvanian absent) in the southeastern Florida Mountains; the coarse-grained chert and limestone conglomerates in the Hueco Formation of the Tres Hermanas Mountains; and the conglomerates in the Abo red beds on Cooks Peak and near Santa Rita that rest unconformably on Pennsylvanian strata.

No fossils have been found in the Beartooth Quartzite (an orthoquartzite). The age was considered Late Cretaceous by Lasky (1936) and Spencer and Paige (1935) and Early Cretaceous by Darton (1928). Lithologically, it is similar to the Sarten Sandstone which crops out 20 miles to the southeast on Cooks Peak. Fossils from the middle of the Sarten Sandstone are of Early Cretaceous age, and suggest that the Beartooth Quartzite is also of Early Cretaceous age. However, the upper part of even the Sarten Sandstone may be of Late Cretaceous age. Time and faunal breaks are not necessarily wedded to lithologic changes.

The Sarten Sandstone, Beartooth Quartzite, and the Dakota Sandstone (the latter has been mapped in the southern Caballo Mountains 40 miles east-northeast of Cooks Peak and in the southern San Andres Mountains 65 miles east of Cooks Peak) of the region from Silver City eastward to the San Andres Mountains may be interpreted as a time-parallel unit with a lower part of Early Cretaceous age and an upper part of Late Cretaceous age or as a time-transgressive unit passing from Early Cretaceous age in the south into Late Cretaceous age to the north.

Near Santa Rita, lenses of conglomerate containing rounded quartzite and chert pebbles occur in the upper part of the Beartooth Quartzite. Spencer and Paige (1935) suggested this conglomerate may mark a break between Lower and Upper Cretaceous strata.

In southwesternmost New Mexico, Early Cretaceous clastic units are unconformable on middle Permian units, chiefly the Concha Limestone and the underlying Scherrer Formation in the Big Hatchet, Animas, Peloncillo, and Chiricahua Mountains. These Middle Permian units, mainly of carbonate rocks, seem to have been deposited across the entire region and graded laterally to the northeast into the Glorieta Sandstone and San Andres Limestone of the central New Mexico sections.

The southwestern edge of the Burro uplift was near the central part of the Pyramid Mountains where Flege (1959) mapped an augite andesite sequence of agglomerates, flows, and breccias which may be of Cretaceous age, similar to andesites in the Peloncillo Mountains. The lower part of this andesite contains local conglomerates of rounded boulders and huge blocks of augite basalt, of Precambrian-looking granite, and of Paleozoic limestones. The andesite is unconformable on augite basalt believed by Lasky (1938) to be of Early Cretaceous age.

LOBO FORMATION

The so-called Lobo strata on Cooks Peak are fossiliferous correlatives of the Abo red beds. Darton (1928) also labeled some red beds in the Victorio Mountains as the Lobo formation. The lower part of these beds contains Early Cretaceous fossils, unconformably overlies the Montoya and Fusselman Dolomites, is 600 to 800 feet thick, and consists of interbedded light-gray to pink conglomerates, siltstones, and fossiliferous limestones. Most of the detrital fragments are of quartz, chert, silicified limestone, carbonate rocks, and some feldspars. Local lenses of altered andesite breccia and andesite conglomerate occur near the base of the sequence.

Unconformable above these fossiliferous beds are unaltered Tertiary(?) andesite agglomerates, breccias, tuffs, and sandstones. Rounded boulders and pebbles of andesite, of early Paleozoic dolomites, of various Early Cretaceous rocks, and minor amounts of Precambrian schist, granite, and pegmatite occur interspersed in this volcanic sequence. These andesites, at least the lower tuffs and breccias, are reddish and may be the sequence called Lobo by Darton. These volcanic rocks and the small amount of included sedimentary lenses may be of Late Cretaceous age, but are not as altered as are the andesites of typical Late Cretaceous units such as the McRae Formation.

The type Lobo formation, named from Lobo Draw in the Florida Mountains, unconformably overlies rocks ranging from the Hueco Limestone down to Precambrian granites and schists. In the southeastern part of the range, red silty shales and limestone conglomerates, similar to parts of the type Lobo, are unconformable on Hueco Limestone and Precambrian granite. In the northern Floridas, the type Lobo unconformably overlies eroded hills cut in the Ordovician El Paso Limestone and Montoya Dolomite, and in Precambrian rocks.

Local pockets on the pre-Lobo surface are filled by lenses of limestone nodules in a reddish-purple calcareous silty shale matrix; angular cobbles of pre-Lobo rocks are scattered through the nodular limestone and red shale. These basal Lobo lenses resemble parts of the Cooks Peak Abo red beds but appear to grade upward into the main mass of the type Lobo.

Above the basal depression-filling lenses, the Lobo, about 300 feet thick, consists of intercalated gray to light-red limy siltstone and very silty limestone, light-red, gray, and purple shale, and yellowish-brown to light-gray, limy, conglomeratic sandstone and conglomerate. Even the fine-grained rocks contain many angular sand-sized grains of quartz, chert, and dolomite. The clasts from pebble to boulder size are mainly chert, early Paleozoic rocks, and Precambrian quartzite and granite. A distinctive reddish granite first occurs as large clasts in conglomerates in the upper third of the Lobo Formation.

The type Lobo is overlain unconformably by Tertiary(?) volcanic and sedimentary rocks whose basal beds are conglomerates composed of rounded cobbles and boulders of purple andesite, gray latite, chert, red granite, and carbonate rocks, and are similar in aspect to the basal Tertiary(?) of the Victorio Mountains. As in the Victorios, the main mass of the Tertiary(?) sequence is of andesite tuffs and breccias.

The Lobo formation of the Florida Mountains appears to be post-Hueco and probably pre-Tertiary in age. In part it resembles the red shales and limestone-chert conglomerates of Early Cretaceous age in the western Tres Hermanas Mountains 15 miles to the southwest, or the Late Cretaceous McRae Formation of the northern Caballo Mountains 80 miles to the north-northeast, or even the early Tertiary(?) Love Ranch Formation 60 miles to the east-northeast in the southern San Andres and Organ Mountains. Considering the regional geologic history, it appears more likely to be related to the Burro uplift than to either Laramide orogeny or to early Tertiary uplift and erosion. Thus Lobo deposition occurred during earliest Cretaceous time.

SUBSURFACE DATA

Five deep oil tests have been drilled in southwestern New Mexico southwest of the Rio Grande Valley in the last three years and have yielded stratigraphic in-

formation if not production. The Humble Oil & Refining Co. No. 1-BA State, drilled during 1958 in sec. 25, T. 32 S., R. 16 W. southwest of the Big Hatchet Mountains, was also an informative test. In this well, a thick section of Permian and Pennsylvanian strata was encountered, similar in many respects to Zeller's (1965) measured sections in the Big Hatchet Mountains.

The Sinclair Oil & Gas Co. No. 1 Federal, drilled during 1962 in sec. 27, T. 22 S., R. 1 W., 15 miles west-northwest of Las Cruces in the southern foothills of the Robledo Mountains, penetrated almost 3000 feet of andesite-latite tuffs and breccias before crossing (probably) a fault into lower Hueco limestones; the rest of the strata encountered were similar to the sections exposed in the northern Robledos except some units were thickened by inclusion of thick rhyolite sills.

The Boles No. 1 Federal, drilled in sec. 7, T. 24 S., R. 1 W. about 12 miles west-southwest of Las Cruces during 1962, reportedly was in "basin fill and rhyolite" to T. D. of 5180 feet.

The Pure Oil Co. No. 1-H Federal, drilled during 1961-1962 in sec. 24, T. 28 S., R. 2 W. on the northeast flank of the East Potrillo Mountains, probably encountered steeply dipping and faulted beds along the border fault zone of the East Potrillo Mountains. Most of the strata penetrated appear to be similar to the Early Cretaceous limestones that crop out in the range, except for the Tertiary diorite sill at the bottom of the test. Much fresh water was obtained from the faulted limestones.

Two oil tests have been drilled on the west edge of the West Potrillo Mountains in southeastern Luna County. The main mass of the West Potrillo Mountains is basalt flows and cinder cones; near the southwest edge where the oil tests were drilled, rhyolitic and latitic flows crop out. Several small patches of fossiliferous Early Cretaceous limestone, fossiliferous Hueco limestone, and the Fusselman Dolomite are scattered amid the sand dunes, and a small diorite plug forms low hills.

The Sunray Mid-Continent Oil Co. New Mexico Federal R oil test was drilled during 1962 in sec. 27, T. 28 S., R. 5 W. on the southeast edge of Indian Basin, a possible volcanic collapse feature, 35 miles southeast of Deming. Almost 3000 feet of volcanic rocks were penetrated before the Fusselman Dolomite was encountered; the lower Paleozoic section was thickened by steep dips. A thin Devonian unit may occur above the Fusselman, but no known upper Paleozoic or Cretaceous rocks were found. A white quartz-rich sandstone above the Paleozoic strata includes much volcanic detritus, and probably is Tertiary in age.

The Skelly Oil Co. No. 1-A New Mexico C oil test, drilled during 1963-1964 in sec. 19, T. 28 S., R. 5 W. about 2½ miles west-northwest of the Sunray test, was spudded just east of the recent fault scarp that borders the sandy western foothills of West Potrillo Mountains. Geophysical data suggest a deep graben directly to the west. The base of Quaternary sand and clay was at about 650 feet, and then rhyolitic and latitic tuffs were drilled to a depth of about 8390 feet where several hundred feet of dolomite were encountered, underlain by about 170 feet of limestone and then almost 500 feet of sandstone and some sandy limestone on top of Precambrian granite. Unless the section is cut up by faults, dolomitized El Paso Limestone occurs beneath the Tertiary volcanic rocks, with Bliss Sandstone above the Precambrian rocks.

The Fusselman Dolomite crops out on Coyote Hill two miles southwest of Indian Basin; two miles to the east, a small ridge exposes Hueco Limestone faulted against Cretaceous strata. At Eagle Nest, four miles north of Indian Basin, Early Cretaceous limestones and sandstones crop out.

These outcrops and oil tests suggest geologic relations similar to those in the Florida Mountains 15 miles to the northwest. Early Cretaceous strata may be unconformable on Paleozoic beds ranging from the Hueco Limestone down to the El Paso Limestone, and Tertiary volcanic sequences unconformable on the Cretaceous and older rocks.

The Burro uplift may have extended much farther to the southeast than has been thought. The erosion during early and middle Mesozoic time, beginning in late Paleozoic time, is related to similar uplift and erosion in northern Chihuahua (Diaz and Navarro, 1964; Bridges, 1964).

REFERENCES

Armstrong, A. K., 1962, *Stratigraphy and paleontology of the Mississippian System in southwestern New Mexico and adjacent southeastern Arizona:* New Mexico Bur. Mines and Mineral Res. Mem. 8, 99 p.

Bachman, G. O., 1961, *Pre-Pennsylvanian Paleozoic stratigraphy, Mockingbird Gap quadrangle, New Mexico:* U.S. Geol. Surv. Prof. Paper 424-B, p. 119-122.

Balk, Robert, 1961, *Geologic map and sections of Tres Hermanas Mountains:* New Mexico Bur. Mines and Mineral Res. Geol. Map 16.

Bogart, L. E., 1953, *The Hueco (Gym) limestone, Luna County, New Mexico:* Univ. New Mexico unpub. master's thesis, 91 p.

Bridges, L. W., 1964, *Paleozoic high inferred from conglomerate outcrops composed of Precambrian metasediments in northeastern Chihuahua, Mexico:* West Texas Geol. Soc. Guidebook, Geology of Mina Plomosas-Placer de Guadalupe area, Chihuahua, Mexico, p. 85-92.

Darton, N. H., 1928, *"Red Beds" and associated formations in New Mexico, with an outline of the geology of the state:* U.S. Geol. Survey Bull. 794, 256 p.

Diaz, E., and Navarro, Arsenio, 1964, *Litologia y correlacion estratigrafica del Paleozoico Superior en la region de Palomas, Chihuahua, Mexico:* Bull. Assoc. Mex. Petrol. Geologists, v. 16, p. 107-120.

Dunham, K. C., 1935, *The geology of the Organ Mountains:* New Mexico Bur. Mines and Mineral Res. Bull. 11, 272 p.

Elston, W. E., 1957, *Geology and mineral resources of the Dwyer quadrangle, Grant, Luna, and Sierra Counties, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 38, 86 p.

———, 1958, *Burro uplift, northeastern limit of sedimentary basin of southwestern New Mexico and southeastern Arizona:* Am. Assoc. Petroleum Geologists Bull., v. 42, p. 2513-2517.

Epis, R. C., 1956, *Geology of the Pedregosa Mountains, Cochise County, Arizona:* Univ. California Ph.D. doctoral dissertation, 181 p.

Flege, R. F., 1959, *Geology of the Lordsburg quadrangle, Hidalgo County, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 62, 36 p.

Gillerman, Elliot, 1958, *Geology of the central Peloncillo Mountains, Hidalgo County, New Mexico, and Cochise County, Arizona:* New Mexico Bur. Mines and Mineral Res. Bull. 57, 152 p.

Griswold, G. B., 1961, *Mineral deposits of Luna County, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull 72, 157 p.

Harbour, R. L., 1958, *Pennsylvanian and Permian rocks in the northern Franklin Mountains, Texas* (abst.): Geol. Soc. America Bull., v. 69, p. 1727-1728.

———, 1960, *Road log from Las Cruces to Vinton Canyon and Anthony Gap, Pennsylvanian localities in the northern Franklin Mountains:* Roswell Geol. Soc. Guidebook, Northern Franklin Mountains and Southern San Andres Mountains, p. 11-33.

Jicha, H. L., 1954, *Geology and mineral resources of the Lake Valley quadrangle, Grant, Luna, and Sierra Counties, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 37, 93 p.

Kelley, V. C., and Bogart, L. E., 1952, *Gym limestone, New Mexico:* Am. Assoc. Petroleum Geologists Bull., v. 36, p. 1644-1648.

Kelley, V. C., and Furlow, J. W., 1965, *Lower Paleozoic wedge edges in south-central New Mexico:* Geol. Soc. America Bull., v. 76, p. 689-694; (abst.): Geol. Soc. America Program, Rocky Mountain Sect. meeting, p. 38.

Kelley, V. C., and Silver, Caswell, 1952, *Geology of the Caballo Mountains:* Univ. New Mexico Pub. in Geol., No. 4, 286 p.

Kottlowski, F. E., 1959, *Sedimentary rocks of the San Andres Mountains:* Roswell Geol. Soc. and Perm. Basin Sect., Soc. Econ. Paleo. & Min. Guidebook, Sacramento Mountains, p. 259-277.

———, 1960a, *Reconnaissance geologic map of Las Cruces thirty-minute quadrangle:* New Mexico Bur. Mines and Mineral Res. Geol. Map 14.

———, 1960b, *Summary of Pennsylvanian sections in southwestern New Mexico and southeastern Arizona:* New Mexico Bur. Mines and Mineral Res. Bull. 66, 187 p.

———, 1960c, *Depositional features of the Pennsylvanian of south-central New Mexico:* Roswell Geol. Soc. Guidebook, Northern Franklin Mountains and Southern San Andres Mountains, p. 96-130.

———, 1963, *Paleozoic and Mesozoic strata of southwestern and south-central New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 79, 100 p.

Kottlowski, F. E., Flower, R. H., Thompson, M. L., Foster, R. W., 1956, *Stratigraphic studies of the San Andres Mountains, New Mexico:* New Mexico Bur. Mines and Mineral Res. Mem. 1, 132 p.

Kottlowski, F. E., and Foster, Roy W., 1962, *Pre-Tertiary strata of Tres Hermanas Mountains, Luna County, New Mexico:* Am. Assoc. Petroleum Geologists Bull., v. 46, p. 2090-2098.

Kuellmer, F. J., 1954, *Geologic section of the Black Range at Kingston, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 33, 100 p.

Lasky, S. G., 1936, *Geology and ore deposits of the Bayard area, Central mining district, New Mexico:* U.S. Geol. Survey Bull. 870, 144 p.

———, 1938, *Geology and ore deposits of the Lordsburg mining district, Hidalgo County, New Mexico:* U.S. Geol. Survey Bull. 885, 62 p.

Laudon, L. R., and Bowsher, A. L., 1949, *Mississippian formations of southwestern New Mexico:* Geol. Soc. America Bull., v. 60, p. 1-87.

Otte, Carel, 1959, *Late Pennsylvanian and early Permian stratigraphy of the northern Sacramento Mountains, Otero County, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 50, 111 p.

Pray, L. C., 1961, *Geology of the Sacramento Mountains Escarpment, Otero County, New Mexico:* New Mexico Bur. Mines and Mineral Res. Bull. 35, 144 p.

Sabins, F. F., Jr., 1957, *Stratigraphic relations in Chiricahua and Dos Cabezas Mountains, Arizona:* Am. Assoc. Petroleum Geologists Bull., v. 41, p. 466-510.

Spencer, A. C., and Paige, Sidney, 1935, *Geology of the Santa Rita mining area, New Mexico:* U.S. Geol. Survey Bull. 859, 78 p.

Zeller, R. A., 1965, *Stratigraphy of the Big Hatchet Mountains area, New Mexico:* New Mexico Bur. Mines and Mineral Res. Mem. 16.