GUIDEBOOK

of the

Border Region

EDITORS

Diego A. Córdoba
Sherman A. Wengerd
John Shomaker

NEW MEXICO GEOLOGICAL SOCIETY

TWENTIETH FIELD CONFERENCE — OCTOBER 23, 24, AND 25, 1969

PRESIDENT'S MESSAGE

On behalf of the Executive Committee and members of the New Mexico Geological Society, Inc., I welcome you to our Twentieth Annual Field Conference. The society is indeed honored and fortunate to be able to sponsor this tour in our neighboring State of Chihuahua.

Acknowledgment to the individuals and organizations who have contributed to the success of this field conference is made in the following messages and in the Guidebook texts. However, I would like to mention several people who have played particularly important roles in organizing this conference. First and foremost is William E. (Bill) King, our General Chairman. This tour of Northwestern Chihuahua has been Bill's labor of love for over two years. Without his pushing, prodding, words of encouragement, and just plain old hard work, this conference would not have been held.

Our editors, Diego Córdoba, Sherm Wengerd, and John Shomaker, have greatly assisted Bill in his task by compiling, and in part, creating, a guidebook that is as good as, and might even be better than, any of our previous guidebooks to the geology of New Mexico and adjacent areas.

The work of the Road Log Committee Chairmen, Roy Foster and Bob Weber, must also be especially acknowledged. The road logging for this conference involved some original geologic work, particularly in the volcanic range areas, in addition to compilation of a considerable amount of unpublished information furnished by our colleagues in various agencies of the Mexican Federal Government and the National and State Universities.

Finally, I want to acknowledge the contribution to the field conference that has been made by the West Texas Geological Society, and particularly by L. W. (Dan) Bridges. The 1964 field trip of that group to east-central Chihuahua (W.T.G.S. Publication No. 64-50) in a real sense "broke the ice" and provided an inspiration and a mark to equal or exceed in terms of field conference organization and guidebook preparation. The two field conference guidebooks in no way represent a duplication of geological society efforts, and should be companion volumes on the bookshelf of any person really interested in the great international Border Region.

The "President's Message" is usually a place where past actions of the New Mexico Geological Society, Inc. are reviewed, and plans and hopes for the future are expressed.

Our twenty field conference guidebooks and other publications represent the fruits of many past labors by many people. *The History of the New Mexico Geological Society*, by Stuart A. Northrop, which 1970 members of the Society received at the conference registration, gives all the details of what we have done or have attempted to do.

As for the future, I expect that twenty more excellent field conference guidebooks will be prepared in the next twenty years. In addition, I expect to see the completion of geologic road logging of all major and many lesser highways in the State of New Mexico within the next several years. The newly elected slate of officers of the Society, demonstrates that our organization is a dynamic one in terms of new faces and ideas. The long-time Society stalwarts are always here to give the needed continuity to our operations, but ours is an up-and-going group, as is our profession, and new wine is needed to keep old skins in shape.

John Hawley

SOME COMMENTS BY THE GENERAL CHAIRMEN

Whether it will become apparent or not in the next three days, this Field Conference has been in preparation for over two years. Many problems not common to field trips in the United States have had to be solved. The cooperation of the Instituto de Geología, Petróleos Mexicanos and Secretária de Recursos Hidráulicos, as well as the aid of many individual Mexicans, has been invaluable.

The Conference will be beneficial to geologists of both nations in the understanding of the geology of the Border Region. It is our hope also that many lasting friendships will be fostered.

May we ask each of you to do in México as the Mexicans do . . . relax. There will be malfunctions during the Conference, there is no doubt of that, but please accept these minor difficulties in good spirits. As a matter of fact, if you do not have a sense of humor, you probably should not be on this Conference. You will find the Mexican scientists a charming people who, while they do not necessarily have the same compelling and possibly idiotic sense of urgency as North Americans do, accomplish very sophisticated scientific work and organize their resources very efficiently.

If the coverage of some aspects of the geology is less than adequate, remember that Chihuahua is relatively virgin territory, and little is known about some parts of this beautiful region.

Finally, we will say that if we had the task of being General Chairmen of a Mexico field conference to do again, we would.

Bienvenidos á Chihuahua y feliz viaje!

Bill King
John Hawley

A CO-EDITOR'S LETTER FROM MEXICO

Sr. John W. Hawley
Presidente de la Sociedad
Geológica de Nuevo México
P r e s e n t e.

Estimado John:

Por fin hemos terminado la edición del vigésimo Libreto Guía de la Conferencia Anual de Campo. Creeme que la labor de editor en un trabajo de esta envergadura no es nada sencilla y en ocasiones es cansada, pero puede llegar a ser agradable, como en este caso, cuando se ha tenido una colaboración, tan amplia de toda la Mesa Directiva de la Sociedad Geológica de Nuevo México. Creo que la Sociedad puede, una vez más, estar orgullosa de la calidad de este libreto Guía, no sólo por los trabajos que contiene, sino por su presentación y principalmente por su significado.

Los geólogos mexicanos que hemos colaborado en la edición, preparación y en la presentación de trabajos geológicos en este Libreto Guía, estamos orgullosos de la labor realizada por la Sociedad Geológica de Nuevo México, al lograr la integración de una serie de estudios científicos en la zona fronteriza. Este esfuerzo debe servir como ejemplo para otras organizaciones, tanto mexicanas como norteamericanas.

Estoy seguro de que una vez más, nuestra Conferencia de Campo será un éxito.

Tu amigo,

Diego A. Córdoba
Co-Editor (México)

OBSERVATIONS BY A CO-EDITOR

Appropriately enough, this Guidebook for the 20th Field Conference is one of the most comprehensive yet published by the New Mexico Geological Society, and, although the articles cover a large segment of the Border Region of northern Mexico and the southwestern United States, the entire trip is in Chihuahua, our first conference entirely outside the United States! Always a large state filled with big enterprising people, Chihuahua has produced a great part of the mineral wealth of Mexico and has nurtured some of Mexico's most dedicated revolutionaries in that country's fight for freedom. The political stability and financial acumen of this fast-growing Republic allow one now to turn the coin around and call Mexico today a veritable "Colossus of the South."

Many authors, committee members, and field trip leaders have done the considerable amount of work represented by this Guidebook and the field conference. Errors there no doubt are, for production of such a Guide involving diverse authors from two different countries (including Texas!) is a long involved process. Nonetheless, and perhaps in misplaced apology, the editors have given authors almost completely free rein in presenting the results of their work. Editors are seldom well-enough versed in all facets of geology, hence care was exercised not to challenge their many diverse opinions or to "play" judge without having done all of the geological work. If some authors have taken what to you look like untenable positions in their papers, challenge them on the trip, *at the microphone*. I can assure you that some authors will challenge each other! Much discussion, vigorous defense, offensive sallies, downright arguments short of fisticuffs, and new observations are sought in this Conference, so let's have at it, with vigor!

Quién no se atrevé, no pasa el mar.

Sherman A. Wengerd
Co-Editor (United States)

FIELD TRIP LEADERS

The men who will lead this three-day field conference include: Roger Morrison, C. C. "Tex" Reeves, Co-chairman John Hawley, Co-editor Diego Córdoba, William Strain, Jorge Tovar, Robert Weber, Carlos Garcia-Gutierrez, David LeMone, Donald Webb, José Guerrero, Edward Berg, Harold James, Roy Foster, Luis Caire, Jerry Hoffer, Alejandro Solis, and your conference General Chairman, William King. There may well be others, among them such hecklers as Jim Wilson, Dan Bridges, Frank "Irish" Kottlowski, Santiago Reynolds, Sherm Wengerd, Zoltan de Cserna, Keith Young, Larry Werts, and Ron DeFord. You may see almost all of these names also as author, committeeman, road-logger, or editor; but this is not a closed corporation, and every conference participant who has observations to make will be handed the microphone upon request, volume turned up LOUD! The field trip leaders may even allow some of the officers of the New Mexico Geological Society to have a word or two. Last, possibly least, but never on purpose, if we've left any field trip leader out of the list, below is a prominant blank space designated specifically so that every conference participant who adds to the success of this trip can write his name in his own Guidebook!

SCHEDULE OF CONFERENCE

Wednesday, October 22 — *Registration Day*

9:00 A.M.-10:00 P.M. Registration in lobby of Camino Real Hotel, Juarez, Mexico. Early breakfast tomorrow is on you.

Thursday, October 23 — *First Day Field Trip*

7:30 A.M.-8:00 A.M. Caravan buses assemble at Camino Real Hotel, Juarez, Mexico. Departure time 8:00 a.m. (Sharp, it says here!) Late pre-registered arrivals check with Bill King.

Lunch, Stop 2, Camel Mountain Escarpment. (Who knows when? Or what?)

Barbecue at Motel El Ranchito, Casas Grandes, late p.m. (After the necessary pre-prandial dust-cutting refreshments.)

Friday, October 24 — *Second Day Field Trip*

7:30 A.M.-8:00 A.M. Caravan buses assemble at Motel El Ranchito, Casas Grandes; departure time 8:00 a.m. sharp, *after* an early breakfast.

Lunch stop somewhere between Buenaventura and Mina La Mojina around the middle of the day (maybe!)

Banquet, and cocktail hour or two, at 8:00 p.m. (or later), Hotel Fermont, Ciudad Chihuahua. Banquet speaker will be Ing. Guillermo P. Salas. "Big Bill," formerly Director of the Mexican Geological Institute, and that famous torero of the 1968 G.S.A. Convention in Mexico City, was General Chairman of that convention, and is now with Recursos Minerales Non-renovables.

Saturday, October 25 — *Third Day Field Trip*

7:30 A.M.-8:00 A.M. Board buses near Hotel Fermont ready to leave at or near 8:00 a.m. after breakfast at the hotel.

Lunch stop mile 143.2, placita at Villa Ahumada at high noon. A box lunch —just like yesterday—and the day before.

Late afternoon arrival at Camino Real, Ciudad Juarez, after a great exploratory tour of northern Mexico. Dinner on you and don't forget your car!

FIRST DAY

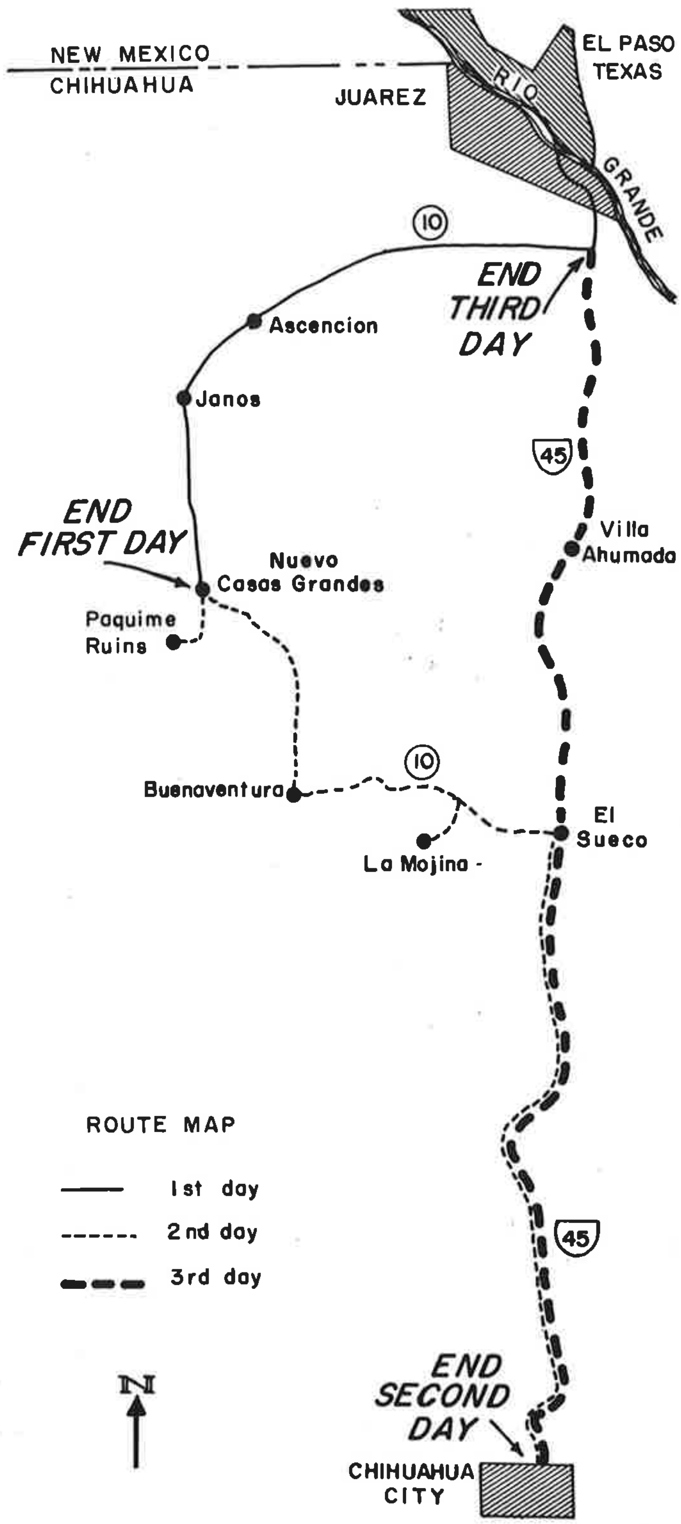
ROAD LOG FROM CIUDAD JUAREZ TO NUEVO CASAS GRANDES, VIA SIERRA DE JUAREZ, SIERRA BOCA GRANDE, ASCENCION, AND JANOS

October 23, 1969

DRIVING DISTANCE:
172.2 mi., 277 Km.

STARTING TIME:
8:00 A.M.

ASSEMBLY POINT:
Hotel Camino Real, Cd. Juarez, Chihuahua



SUMMARY

Much of the first day's route is across the broad bolson plains of northwestern Chihuahua. During this part of the trip we will learn much about the geologic history of these basins and their potentially important water supplies. The traverse is punctuated by a stop at the southern end of the Juarez Mountains to visit some Lower Cretaceous reefs and at the pass south of Sierra Boca Grande where Permian rocks are exposed. The remainder of the trip more or less follows the irrigated Rio Casas Grandes valley past exposures of Tertiary volcanics.

Cumulative Mileage (Kilometers to nearest tenth)

0.0 Camino Real, Ciudad Juarez. Proceed on Avenida Lopez Mateos.

0.4

0.4 (0.6) Centro Artesenal.

0.6

1.0 (1.6) Intersection with Calle "16 de Septiembre." TURN LEFT ONTO MEX. 45.

0.3

1.3 (2.1) Plaza Monumental bull ring on right. Olé.

0.8

2.1 (3.4) San Lorenzo section of Juarez. The route curves to the right and continues south across the Rio Grande (Rio Bravo del Norte) flood plain.

This segment of the river valley, the Valle de Juárez, is currently the site of an intensive ground-water investigation by the Mexican Federal-Secretaria de Recursos Hidráulicos. Test drilling indicates that the thickness of unconsolidated basin fill in the Juárez-Guadalupe-Bravo area is at least 1475 feet (450 meters). Over much of the valley floor a thin deposit (less than 100 feet, 30 m.) of late Quaternary alluvium overlies early Pleistocene (?) and older Santa Fe Group basin fill. Below the flood plain, the explored part of the Santa Fe Group consists of interstratified sand and clay with local zones of gravel. A basal gravel is usually present in the young valley-fill unit. (See Strain, and Metcalf, this guidebook) About 25 miles (40 km) southeast of this point, near Juárez y Reforma, artesian wells with flow capacities of up to 1000 g.p.m. are being constructed. The artesian pressure in an aquifer about 1000 ft. (300 m.) deep is as much as 38 p.s.i. at the flood plain surface and is known to increase in a southwesterly direction toward Sierra del Presidio. The water contains less than 1000 p.p.m. total dissolved solids. Water temperature is as high as 95° F (35° C). In contrast, the quality of the shallow ground water is commonly poor in the Valle de Juárez, as is some of the water encountered near the base of the explored basin-fill section.

Information on the hydrogeology of basin and valley fill deposits used in this road log was kindly provided by Ings. Dominguez and Fuentes of the S.R.H. Staff, Chihuahua City, with permission of Ing. Carlos Carvajal, Chief.

0.6

2.7 (4.3) Intersection on left to Juarez dog track.

0.6

3.3 (5.3) Intersection with Mex. 2 to Porvenir. CONTINUE STRAIGHT AHEAD ON MEX. 45.

0.1

3.4 (5.5) Chihuahua State Police Headquarters on right.

1.0

4.4 (7.1) Hotel Villa Real on right.

0.6

5.0 (8.1) Sierra Juárez on right; Lower Cretaceous Albian limestone, sandstone, and shale. (see Córdoba, this guidebook).

1.0

6.0 (9.7) South edge of Rio Grande flood plain.

0.4

6.4 (10.3) Ascending onto series of terrace levels formed by cyclic entrenchment of the Rio Grande valley in late Pleistocene time. Rogélio's Hotel on left.

1.6

8.0 (12.9) Lechería Zaragoza (dairy) on right. Where's the grass?

1.3

9.3 (15.0) Juárez Municipal Airport on left. Sierra del Presidio at 10:00; Sierra de Samalayuca at 11:30. The bluffs on skyline from Sierra del Presidio to Juarez are capped by La Mesa surface and underlain by sandy sediments of the upper part of the Santa Fe Group. (Hawley et al., 1969, Fig. 1). Studies of vertebrate faunas by Strain (1966) indicate that most of the exposed basin-fill deposits in Hueco bolson are of early to middle Pleistocene age.

The airport is located on an intermediate basin-floor surface about 175-200 feet above the Rio Grande flood plain; 100 feet below

East front of Juárez Mountains from Juárez Airport, mile 9.3.

the level of the Hueco bolson floor north of the river valley; and 250 feet below the ancient La Mesa surface. Test drilling by the Secretaria de Recursos Hidráulicos for industrial park sites southwest of the airport shows that the basin fill is at least 940 feet (287 m) thick and consists mainly of fine-to-medium-grained sands. The water table in this area is at about the same elevation as the Rio Grande flood plain.

2.1

11.4 (18.4) Junction Mex. 45 and Mex. 10. TURN RIGHT ON MEX. 10.

0.4

11.8 (19.0) Railroad crossing. Franklin Mountains at 3:00.

0.9

12.7 20.4) Railroad crossing.

0.3

13.0 (20.9) Begin ascent to ancient basin surface at the western extremity of Hueco bolson (Hill, 1900). Caliche-cemented gravels exposed along side of road.

2.4

15.4 (24.8) TURN RIGHT onto dirt road for Stop 1. Route continues on piedmont-slope component of basin surface, probably equivalent to either the Jornado or Dona Ana surfaces of the northern Mesilla bolson area (Ruhe, 1967, Hawley and Kottlowski, 1969). These surfaces grade to the general La Mesa level and are of middle Pleistocene age. Surficial alluvial-fan gravels, derived from a large canyon extending into the southern Juarez Mountains, are cemented in a prominent caliche caprock zone. (Gile et al., 1965).

0.8

16.2 (26.1) Road on left at outcrop of Cretaceous limestones. Continue straight ahead.

0.1

16.3 (26.2) STOP 1. Walk north across large dissected fan to Cretacious reef exposures.

Stop 1 discussion by Ing. Diego Córdoba
Southwestern end of Sierra de Juarez:
We will be looking at the lower Cretaceous Cuchillo Formation (Aptian), made of:

a) *lower part:* brownish calcareous sandstone, gray limestone, biostromatic gray limestone, conglomeratic (chert fragments) gray limestone. Fossiliferous content: *Exogyra* sp. and *Cardium* sp.
b) *middle part:* reddish brown limestone, brown calcareous shale, gray shale. Fossiliferous content: *Exogyra* sp., *Ostrea* sp. and *Dufrenoya* sp.
c) *upper part:* dark gray limestone and pinkish calcareous sandstone (partially conglomeratic). Fossiliferous content: *Exogyra* sp. and *Ostrea* sp.

The Cuchillo is overlain by the Benigno Formation (Albian), made of:

a) *lower part:* gray shale, gray calcareous siltstone and shale. Fossiliferous content: *Trigonia* sp., *Ostrea* sp. and undetermined echinodermata.
b) *middle part:* thin-bedded gray limestone, with *Orbitolina texana.*
c) *upper part:* thick-bedded to massive, gray to brown limestone; containing *Caprina* sp. and *Toucasia* sp.

Following stop, retrace route to Mex. 10.

0.9

17.2 (27.7) Rejoin Mex. 10.

0.3

17.5 (28.2) ADUANA. Inspection station on right. STOP for immigration inspection. Have tourist permits ready.

0.2

17.7 (28.5) ADUANA. Inspection station on right. STOP for vehicle inspection. Have car permit ready.

1.3

19.0 (30.6) Granja Juanita on left. Sierra Mezquite 1 (Lower Cretaceous strata, and Tertiary volcanics and intrusives) from 9:30 to 11:30. Sierra Juérez on right. Creosote bush is dominant vegetation in this part of the upland surface. Brand (1936) places this area in the creosote-yucca-mesquite association of the Chihuahuan desert region.

0.8

19.8 (31.9) Large gravel pit (surficial gravels cemented with caliche) on right is located on the southwestern piedmont slope of the Juárez Mountains. To the west the route crosses the southernmost part of the Mesilla bolson (Hill, 1900), an ancient intermontane basin extending south from Las Cruces, New Mexico, and bounded by the Organ-Franklin-Juárez mountain ranges on the east and the Sleeping Lady-Aden-Potrillo uplifts on the west. During long periods in the early and middle Pleistocene, parts of the bolson floor were occcupied by distributary channels of the ancestral Rio Grande, which entered this region from the Palomas and Jornado del Muerto basins of south-central New Mexico. At various times the ancient Rio

Grande discharged from the Mesilla bolson into the Hueco bolson and the extensive bolson plains of northwestern Chihuahua. The floors of these intermontane basins were the sites of a vast complex of perennial and ephemeral lakes that possibly coalesced into a single body of water during early Pleistocene pluvials. Strain (1966, and in this guidebook) has collectively designated these lakes as Lake Cabeza de Vaca in honor of Alvar Nuñez Cabeza de Vaca, the first European to visit this part of the New World in November 1535 (see Horgan 1954, v. 1).

2.3

22.1 (35.6) Casita with water tower. Descend from the piedmont slope to the broad floor of Mesilla bolson. The basin floor is continuous to the north with middle Pleistocene La Mesa surface (Ruhe, 1964, 1967; Hawley and Kottlowski, 1969).

1.0

23.1 (37.2) Rancho. Caliche pits along the highway expose soils with strong, partly indurated horizons of carbonate accumulation. Pedologic nomenclature used to describe this type of caliche includes the terms: petrocalcic, Ccam, and Km horizons. The "K" terminology has recently been proposed by Gile and others (1965) for master horizons of carbonate accumulation in soils of arid and semiarid regions. Such horizons are almost completely impregnated with secondary carbonate but are not necessarily indurated. (See Appendix to Table 2, Morrison, this guidebook).

The dominant processes of caliche genesis in this region appear to be pedologic (Hawley et al., 1968). Most caliche, as well as weaker zones of lime accumulation occur just below and parallel to older geomorphic surfaces, and they are primarily illuvial accumulations resulting from downward movement of carbonate from surface soil horizons. There is a direct correlation between geomorphic surface age and thickness and morphological complexity of associated caliche horizons if textural, mineralogic, topographic, and climatic factors of soil formulation are kept relatively constant. There is strong evidence for an eolian origin for much of the carbonate. (Gile, et al., 1966). Based on studies of hydraulic properties of basin fills and models of the geomorphic evolution of the Rio Grande valley and adjacent basins, present water-table configuration and hypothetical past configurations indicate that ground-water and capillary-fringe processes have not played an important role in caliche genesis in this area (Hawley et al., 1968; King et al., 1969).

Carbon 14 analyses of caliches in the Las Cruces (New Mexico) and Fort Hancock (Texas) areas indicate that the age of these horizons of carbonate accumulation generally increases with depth (Gile et al., 1966; Grossman et al., 1967; Rightmire, 1967), (Sigalove et al., 1961).

2.1

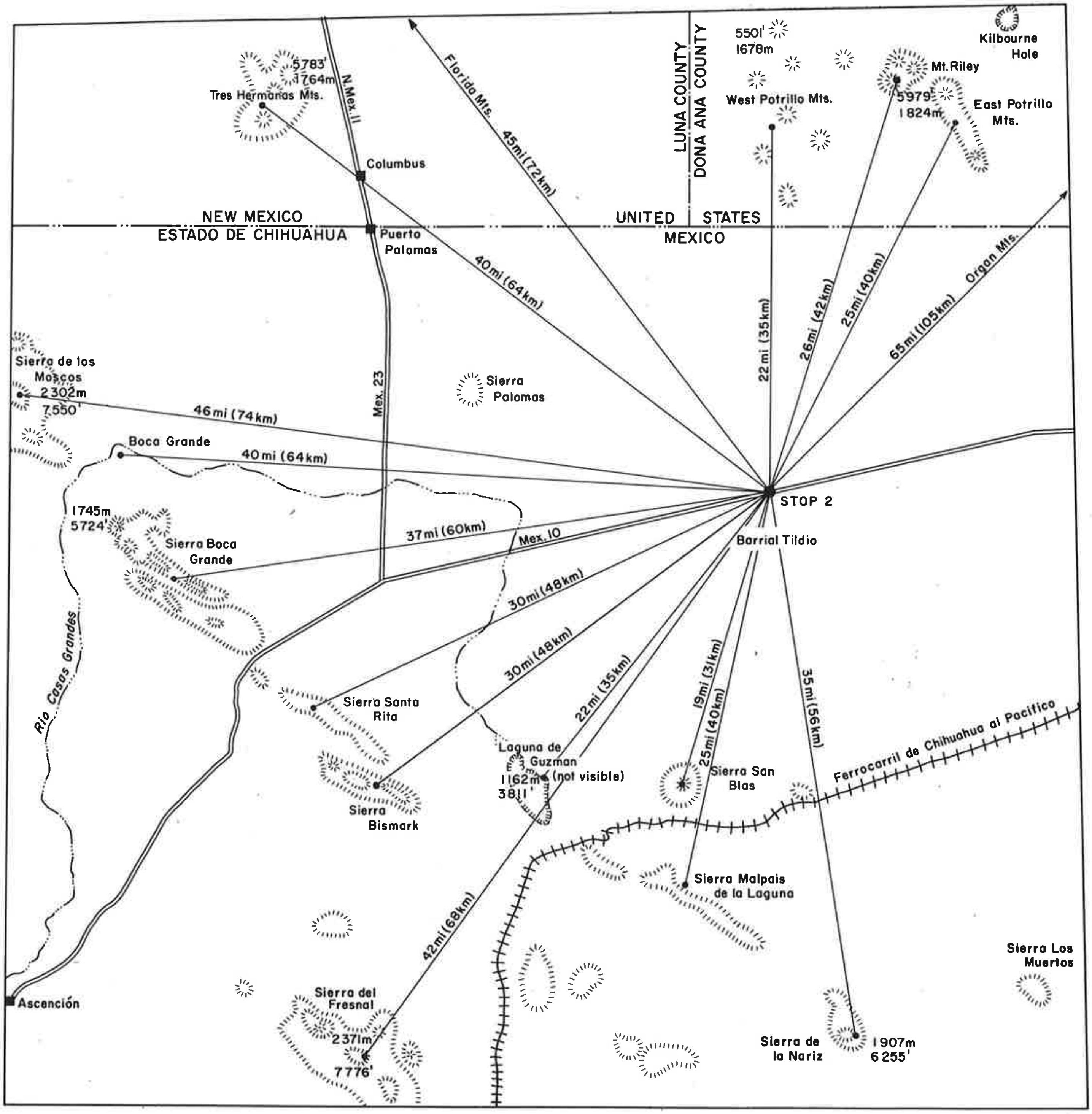
25.2 (40.6) Mount Riley (Tertiary volcanics) and East Potrillo Mountains (Lower Cretaceous strata) at 2:00.

2.6

27.8 (44.8) Road to Rancho las Cuatas on left near northern tip of Sierra Mezquite. Coppice-dune field (Melton, 1940; Gile, 1966).

Melton used the terms "coppice dune" and "shrub-coppice dune" to designate dunes associated with clump vegetation (coppice). Melton states that " . . . on the disappearance of the grasses and other effective sand binders with climatic change, overgrazing, etc., remaining clumps of shrubbery may trap a noticeable amount of sand; mesquite . . . grow vigorously on sand and is not readily killed by slow sand burial. Sand which falls within the bush may thus stay for a considerable time. If this process continues, a mound of sand eventually is built and held together by the coppice as well as local dune fields not stabilized by vegtation, . . ." Coppice-dune fields will be major features of the landscapes seen between stops 1 and 2 of the first day of the conference, and north of stop 2 on the third day.

From the north spur of Sierra Mezquite a northwest trending line runs to the southern tip of the East Potrillo Mountains. In general, this line marks the boundary between the Mesilla bolson and the huge closed-basin complex extending from southern Luna County, New Mexico to the Villa Ahumada area of northern Chihuahua. It has been variously called the "Great Northwest Chihuahua basin", "La Mesa", "Franklin bolson" and "Lake Palomas basin" (Brand, 1936, Sayre and Livingston, 1945, Reeves, 1965). In early through mid-Pleistocene time large areas of the basin floor were flooded and formed the western part of the Lake Cabeza de Vaca system (Strain, 1966, this guidebook). After initial en-



PANORAMIC INDEX
STOP 2

trenchment of the ancestral Rio Grande in the Hueco-Mesilla bolson area, in late-middle Pleistocene time, the major source of water for Lake Cabeza de Vaca was diverted to the Gulf of Mexico. Subsequently less extensive, but still very large lakes have periodically formed in the bolson area during late Pleistocene pluvials. These bodies of water, collectively designated Lake Palomas by Reeves (1965) represent episodes of coalescence of lakes fed by the Rios Casas Grandes, Santa Maria, Carmen and Mimbres.

3.7

31.5 (50.7) At 2:00, West Potrillo (colt) Mountains comprise a Quaternary basalt field. Descend low scarp (trend NNW-SSE) of probable tectonic origin, which extends an unknown distance to the south from the International Boundary.

4.5

36.0 (58.0) Caliche pit on north side of highway. Partly indurated caliche and underlying sands contain scattered rounded pebbles of mixed, generally silicieous composition. Rock types include rhyolite (welded tuff and trace of obsidian), granite, quartz, chert, and basalt. The gravel reflects the composition of bedrock and older basin-fill deposits north of the 32nd parallel, and is not from local sources. The lithology of surficial basin fill in this vicinity is identical to that of the Camp Rice Formation (Upper Santa Fe Group fluvial deposit) in the Mesilla Valley area and farther north. (Refer to paper by Strain in this Guidebook). Reconnaissance mapping along both sides of the International Boundary west of El Paso indicates that a southwestern extension of the main body of the Camp Rice Formation can be traced into the basin area west of Sierra Mezquite[1,2] (King et al., 1969).

1.9

37.9 (61.0) End of pavement as of July 11, 1969. Yucca constitutes the dominant vegetation, accompanied by scattered small mesquite clusters.

1.6

39.5 (63.6) Rancho los Chontes to right.

1.4

40.9 (65.8) Curve.

2.9

43.8 (70.5) Crest of rise. Sierra de la Nariz (mountains of the nose) Lower Cretaceous strata and Tertiary volcanics at 9:00. The low scarp just ahead shows up faintly on photos taken from Apollo 9. (see Morrison, and Webb, this guidebook).

2.8

46.6 (75.0) Road crosses large depression (Blowout? Subsidence? What?).

4.4

51.0 (82.1) Descend hill. Florida Mountains at 2:30 (Precambrian, Paleozoic, Cretaceous, and Tertiary exposures). Sierra Boca Grande (Los Chinos) at 12:00 on distant skyline (Pennsylvanian, Permian and Cretaceous strata). Sierras Bismark and Santa Rita at 11:00.

5.9

56.9 (91.6) STOP 2 (LUNCH STOP—after geology!) on rim of "Camel Mountain escarpment"[3] (Reeves, this Guidebook) and west edge of La Mesa surface. The escarpment at this point is about 150 feet (45 meters) high and overlooks Laguna Tildio (Brand, 1937), a playa (Bryan, 1923), or more correctly, a barrial (Ordoñez, 1936) in the northern part Bolson de Los Muertos. This stop offers a stunning panoramic view of the northern Chihuahuan Desert region (see diagram).

In the upper 50 feet of the escarpment face there are excellent exposures of ancient basin fill capped with a complex caliche zone. Underlying sediments consist primarily of horizontally- to cross-bedded sands, which are partly cemented by calcite. Silt and clay interbeds occur in the lower part of the section. The exposed sequence could represent an ancient fluvial-deltaic deposit, laid down at or near the mouth of the ancestral Mimbres River, where it emptied into a western extension of Lake Cabeza de Vaca.

The Camel Mountain escarpment extends south to southeast from the southeast corner of Luna County, New Mexico. It has generally been considered as a tectonic feature (Kottlowski, 1965; Reeves, this Guidebook). Reeves considers that at least the lower part of the scarp has been modified by wave action during deep stages of pluvial Lake Palomas in mid (?) to late Pleistocene time. Such lakes would have been very large bodies of water. A lake that reached even the base of the escarpment in this area (altitude 1200 meters, or 3937 feet) would have flooded about 2000 square miles, based on present topographic configuration, of the[4] Los Muertos bolson floor. Such a lake would have extended about 100 miles from Arena, New Mexico (107° 25′ W., 31° 47′ N.) to Villa Ahumada, (106° 30′ W., 30° 40′ N),

Looking west across Laguna Tildio from crest of "Camel Mountain Escarpment," mile 56.9.

Contact of upper caliche zone with underlying silt and clay deltaic (?) interbeds, foot of "Camel Mountain Escarpment."

(3rd day, Stop 2) and would have had a maximum depth of over 160 feet (50 meters).

BACK TO BUSES AFTER A SHORT SIESTA!

1.1

58.0 (93.4) Route crosses floor of Laguna Tildio.

2.3

60.3 (97.1) Isolated hill at 9:30 exhibits apparent wave-cut cliffs. Refresqueria on right (warm "cokes" etc.).

62.8 (101.1) Road on right to Ejido Nuevo Cuauhtemoc. Two exploratory wells have recently been drilled for this Ejido by the Secretaria de Recursos Hidráulicos. The deeper of the two is located some miles southeast of this point and penetrated 1197 ft. (365 m.) of unconsolidated basin fill. The general section includes surficial gravel about 130 ft. (40 m.) thick, which overlies 984 ft. (300 m.) of clay. Water under artesian pressure is produced from a basal gravel zone (dominantly rhyolitic volcanics) between 1115 to 1197 ft. (340 to 365 m.), in depth. The piezometric surface is 39 ft. (12 m.) below ground surface. A sixteen-inch well developed in the deep aquifer zone produces up to 1110 gpm (70 l.p.s.) with a small amount of drawdown. The quality of the water is only fair (about 2400 ppm total dissolved solids); however, it is much better than the highly saline water developed from the surficial gravel zone. A second well, drilled at the Ejido, about 1 mile south of the highway, penetrated similar basin-fill materials to a depth of 115 ft. (340 m.), and again encountered water under artesian pressure that rose to within 72 ft. (22 m) of the ground surface. The quality of this water was slightly better (1800 ppm), but the well can produce only about 190 gpm (12 l.p.s.).

3.3

66.1 (106.4) Western edge of playa floor. Road ahead ascends a series of terrace levels (maximum elevation about 3800 feet, 1160 meters) suggestive of abandoned shorelines of pluvial lakes. Note thin, pervasive veneer of fine lag gravel. Apollo 5
9 photographs show two spit-like features about 3 and 6 miles (5 and 10 km) north of this point. (see Morrison, this guidebook). These features may be part of a large lake shoreline and deltaic deposits formed near the mouth of the ancestral Rio Casas Grandes at a time when it emptied into pluvial Lake Palomas (Reeves, 1965). Soils on stable surfaces in this area commonly have a well developed horizon of clay accumulation (argillic B horizon).

1.6

67.7 (109.0) Ejido "6th of January," a communal farm settlement, on left.

Isolated group of volcanic hills at 2:00 with Lower Cretaceous beds on the east. Ground water production in this area is limited to shallow aquifer zones. Deep basin-fill deposits have been tested to a depth of 1000 feet, but yield only saline water. This Ejido is supplied by a 10 ft. (3 m.) diameter well, which is about 40 ft. (12 m.) in depth. Fresh water (about 500 ppm) is produced from a gravel and sand zone between 7 to 12 meters in depth. Relatively fine-grained beds underlie and overlie this unit. The static water level here is about 20 ft. (6 m.) below the land surface.

1.8

69.5 (111.9) East edge of present slightly entrenched valley of Rio Casas Grandes. Route crosses river flood plain several miles southeast of Vado de Piedra.

0.3

69.8 (112.4) Culvert across Rio Casas Grandes distributary.

2.2

72.0 (115.9) Ranchitos north and south of highway. Colonia Vera Cruz to right. Fine-grained flood-plain deposits. Stock wells in the Colonia Vera Cruz area have penetrated as much as 300 ft. (90 m.) of basin fill, generally gravel and sand.

1.2

73.2 (117.9) Puente Vado. Drainageway southward into Laguna de Guzman ahead. This is the now obscure lower course of the Rio Casas Grandes. It heads in the Sierra Madre Occidental south of Casas Grandes, flows northward, turns eastward for 15 miles after leaving the Boca Grande canyon, then turns southward toward Laguna de Guzman. The river enters the barrial (playa) about 12 miles south of this point. The maximum recorded recent extent of Laguna de Guzman was about 16 miles by 5 to 7 miles wide (Brand, 1937). On May 26, 1969, no water was observed in the barrial.

0.2

73.4 (118.2) Ascend low escarpment, which marks the west edge of the Rio Casas Grandes valley and the area presumably flooded by pluvial Lake Palomas. Gravels exposed in the scarp may represent fluvio-deltaic deposits of the ancestral Rio Casas Grandes.

0.4

73.8 (118.8) Gravel pit on right. Cross-bedded gravel, locally capped by a sandy surface veneer, is exposed. Well-rounded clasts are mainly of rhyolite to andesite in the fine to coarse pebble size range. Gravel beds are locally impregnated with carbonate and stained with limonite.

1.9

75.7 (121.9) Crossing broad plain with gentle slope to east, possibly the surface of a large fan or delta built by the ancestral Rio Casas Grandes. Rounded pebble gravel veneers the surface.

2.9

78.6 (126.5) Trail to south leads to Laguna de Guzman and Rancho La Mota Nuevo, site of large travertine-capped spring terraces. These terraces may be associated with former spring activity (Hawley) or shoreline features as suggested by Reeves (1965).

2.5

81.1 (130.6) ADUANA. STOP FOR INSPECTION. Have vehicle permit ready. Junction on right with highway to Palomas. Cafe Lucero ahead on right. (burritos, cold cervesa, and local gossip available.)

1.7

82.8 (133.3) Restaurant El Desierto on right on toe of piedmont slope rising toward Sierra Boca Grande (Los Chinos); approaching edge of Bolson de Los Muertos.

1.1

83.9 (135.1) Isolated volcanic hills on left.

5.1

89.0 (143.3) Road on right to well site of Petroleos Mexicanos Pozo Los Chinos No. 1. Test spudded in Permian rocks on axis of south-plunging anticlinal fold.

1.6

90.6 (145.9) STOP 3 at pass between Sierra de la Boca (Sierra Boca Grande; Sierra de Los Chinos), and Sierra Santa Rita. Sierra Boca Grande, north of the road, consists of about 2400 ft.