

Ed  
2  
Copy 1

Road log from Carlsbad, N. Mex. to Project

Gnome site

By

James B. Cooper

**OFR: 62-30**

Feb. 1962

ROAD LOG FROM CARLSBAD, NEW MEXICO, TO PROJECT GNOME SITE

Prepared by James B. Cooper, United States Geological Survey  
on behalf of the United States Atomic Energy Commission

Starting point (Mile 0.00) is the office of the Atomic Energy Commission, 1030 N. Canal Street. The one-way trip requires about 45 minutes at a moderate rate of speed. The general geographic and geologic setting is described on pages 10 and 11.

Cumulative  
Mileage

0.00 Head SOUTH to Junction with U.S. Highway 285 at traffic light. Bear LEFT on U.S. Highway 285 and continue SOUTH on Canal Street through the business district of the city.

Carlsbad had a population of 25,541 in 1960 and is at an altitude of 3,110 feet in the Pecos River valley of southeastern Eddy County, New Mexico. It is the county seat of Eddy County and is the sixth largest city in the state. The economy of the city is based primarily on agriculture and the production of potash. The oil industry and the accomodation of tourists visiting nearby Carlsbad Caverns National Park contribute much to the local economy. The city is on Mountain Standard Time.

1.20

1.20 Junction with U.S. Highways 62 and 180. Continue STRAIGHT AHEAD on U.S. Highways 285, 62, and 180.

0.60

1.80 Bridge over Dark Canyon Draw.

0.35

2.15 Bridge over Dark Canyon Draw (main channel).

Dark Canyon Draw, a tributary to the Pecos River, drains an area of about 250 square miles in the southern Guadalupe Mountains. The streambed carries water only during or after heavy rainfall.

1.20

3.35 Junction. TURN LEFT and proceed southeast on U.S. Highway 285. Continue past city limits in SOUTHEASTERLY direction.

Cumulative  
Mileage

From the junction, just passed, U.S. Highway 62 and 180 continues to the southwest to the city of El Paso, Texas and the Mexican border. Eighteen miles beyond this junction, at White's City, New Mexico State Highway 7 provides entrance to the Carlsbad Caverns National Park. The caverns are 8 miles west of the main highway. The Carlsbad Caverns National Park was established by act of Congress in 1930. The Caverns are the largest tourist attraction in New Mexico and are visited by thousands of tourists each year. The ten millionth visitor made the tour through the Caverns on Nov. 24, 1961.

1.85

5.20

Irrigation well and pump on the right. This well is 166 feet deep, is 16 inches in diameter, and is finished in sand and gravel. The water is 65 feet below the land surface. The yield of the well is 1,400 gallons per minute. All irrigation wells in the area south of Carlsbad are completed in sand and gravel beds of the alluvium.

Many irrigation wells, some with adjacent earthen storage tanks, may be seen on both sides of the road for the next few miles. The wells are used to supplement surface-water irrigation. Irrigation is essential to grow crops in this semiarid climate. Cotton is the primary irrigated crop. Alfalfa is second in importance. Some maize, barley, castor beans, and pasture grass are also grown. Most days are clear and sunny and the humidity is low. The average annual precipitation of about 13 inches occurs mostly in the form of thundershowers. About 75 percent of the total precipitation is during the growing season--May through October. Summers generally are quite warm with frequent hot days. Winters are normally mild except for occasional storms from the north. About 20,000 acres, in the Carlsbad Irrigation District, are being irrigated with water diverted from the Pecos River at Lake Avalon. The Carlsbad Irrigation District lies in part of a declared ground-water basin in which the development of ground water is administered by the New Mexico State Engineer Office.

1.90

7.10

SLOW. Otis. This is a small farming community. Adjacent to the highway is a cotton gin and other buildings for the storage of grain and seed.

Cumulative  
Mileage

The mountains in view to the WEST and SOUTHWEST are the eastern limb of the Guadalupe Mountains, "La Barrera del Guadalupe." The eastern boundary of La Barrera del Guadalupe is an exhumed reef front that follows the structural and stratigraphic boundary between the Delaware Basin and the northwestern shelf area. The Delaware Basin is a structural feature of Permian age. The reef is a limestone and dolomite unit of Permian age.

3.75

10.85 Junction with State Highway 31. TURN LEFT. Cross Santa Fe Railway tracks. Continue ahead on State Highway 31 to the EAST.

The town of Loving, 2 miles south of the highway, had a population of 1,646 in 1960. Grain-storage elevators and a cotton gin are located there.

2.90

13.75 Railroad tracks.

These tracks are a spur line of the Santa Fe Railway and connect the potash refineries of the U.S. Borax and Chemical Co. and the International Mineral and Chemical Corp. with the branch line at Loving.

0.65

14.40 Bridge over Pecos River.

The Harroun dam is about 2,500 feet upstream to the left. Water is diverted from this dam into the canal on the east side of the river. About 3,000 acres of land, mostly on the east side of the river and extending about 10 miles downstream, are irrigated from this canal. The diversion dam is at the site of the initial irrigation project in the area in 1880.

The dense vegetation in the bottom lands along the Pecos River consists of phreatophytes--water-loving plants that habitually take their water supply either from the zone of saturation or from the capillary fringe above it. The most abundant phreatophyte in southeastern New Mexico is saltcedar (*Tamarix-gallica*). The plant first appeared in this area about 1912. The plant has no economic value and the dense growths consume many thousands of acre-feet of water each year.

Cumulative  
Mileage

The bluff upstream from the dam, on the east side of the river, is known as "Culebra Bluff" and is one of the few outcrops in the area of the Culebra Dolomite Member of the Rustler Formation of Permian age. This dolomite member of the Rustler Formation is a well-known marker bed in the subsurface throughout most of the Delaware Basin. It contains water in many places and is the principal aquifer at the site of Project Gnome where it is present at a depth of about 500 feet.

0.30

14.70 Railroad tracks (spur line to refineries).

You are now traveling NORTHEAST. The plant on the right is the potash refinery of the U.S. Borax and Chemical Co. Water for use in the refining process is obtained from the irrigation canal just passed.

2.50

17.20 Railroad tracks.

These tracks are a narrow-gauge tram line belonging to the U.S. Borax and Chemical Co. and are used for the transport of potash ore to the refinery from the company mine about 14 miles northeast.

0.20

17.40 Laguna Grande de la Sal (Salt Lake) on the right.

This relatively shallow lake now occupies most of a large playa formed in the topographically low depression known as Nash Draw. The lake has no surface outlet and contains salt and a brine solution that has been concentrated by evaporation. Salt was harvested from the lake as early as 1875. Since 1932 the refinery of the U.S. Borax and Chemical Co. has used the lake as a disposal area for the waste brine from their potash refining operations. The large island in the lake is an outcrop of gypsum rock of the Rustler Formation capped by red silt and sand of the Gatuna Formation of Pleistocene(?) age.

0.50

17.90 Red rocks of the Gatuna Formation are exposed to the left in the cut of the tram line tracks.

The Gatuna Formation is composed of clay, silt, sand, gravel, and conglomerate derived from material eroded from the older formations of Permian and Triassic age nearby. The formation is discontinuous in this area.

Cumulative  
Mileage.

Exposed also in the lower part of this outcrop, beneath the Gatuna Formation, is red siltstone of the ~~Dewey Lake~~ <sup>Pierce Canyon</sup> Redbeds of Permian age. These siltstone and sandstone red beds underly most of the area east of Nash Draw. Their maximum thickness is almost 350 feet. At the Gnome site the Gatuna Formation occupies the interval from 40 to 80 feet and the ~~Dewey Lake~~ <sup>Pierce Canyon</sup> Redbeds the interval from 80 to 290 feet below the land surface.

0.40

18.30 Junction with State Highway 128. TURN RIGHT. Cross spur-line railroad track and continue ahead on State Highway 128 to the EAST.

1.20

19.50 The red rock in the hill to the left is an outcrop of the Gatuna Formation overlying the Magenta Member of the Rustler Formation. The Magenta Member is a purplish to magenta dolomitic anhydrite layer, about 20 feet thick. It separates the gypsum of the upper member, from the <sup>the Forty-niner</sup> gypsum of the middle member, of the Rustler Formation. <sup>the Tamarisk</sup> It is present at the Gnome site from 360 to 380 feet beneath the surface.

You are crossing NASH DRAW. The draw is part of the interior drainage system of this area, and is a result of the removal of salt, by circulating ground water, from the top of the underlying Salado Formation of Permian age. Collapse of the Rustler Formation, and subsequent solution and removal of much of the evaporite section, has created the present topographic and geologic feature. Nash Draw is 4 to 6 miles wide and 20 miles long. It extends from the high ridge about 12 miles north of here to the vicinity of Loving and Malaga to the south. In Nash Draw, immediately above the top of the salt, there is a layer of solution breccia composed of gypsum, clay, and silt. This layer contains a concentrated sodium chloride brine that is moving from north to south down the draw. The water in Salt Lake and the other smaller playa lakes is perched above the top of the salt of the Salado Formation by impermeable layers of clay and silt.

Cumulative  
Mileage

At this place the top of the salt is at a depth of about 300 feet, and the brine zone is about 20 feet thick. The brine discharges into the Pecos River at Malaga Bend at a rate of about 200 gallons per minute. It is a major source of contamination of the river water which is used for crop irrigation downstream.

Some of the common plants in this desert area are mesquite, creosotebush, shin oak, snakeweed, sotol, and yucca. The mesquite here is a shrub 5 to 8 feet tall containing many branches on which are paired narrow leaves, thorns, and long seed pods. The creosotebush is an evergreen shrub 3 to 5 feet tall having numerous small leaves and fuzzy white seed balls. The shin oak is a low bushy plant having broad oak-like leaves and thrives in large stands in dune-sand areas. The snakeweed is a bushy annual about 1 to 1½ feet tall, topped by a mass of small yellow flowers. Sotol has a clump of ribbon-like leaves and tiny flowers on a large stem. The yucca has broader leaves than the sotol, and a long stump, ~~(depending on its age, and has~~ <sup>the length of which depends on the age of the plants,</sup> bell-like blossoms.

1.00

20.50

To the LEFT on the horizon (about 5 miles) is the potash refinery of the International Minerals and Chemical Corp. Also in view are several head frames over mine-entry shafts. Approximately 90 percent of the potash production of the United States comes from this general area. Six companies are engaged in mining activities. The mines range in depth from about 850 feet to about 1,800 feet. The mine of the International Minerals and Chemical Corp., near the refinery, produces potassium-magnesium sulfate ore from the 850-foot level and potassium chloride ore from the 900-foot level. The potash minerals are interstratified with salt, anhydrite, and minor argillaceous and clastic rocks of the Salado Formation. The Project Gnome nuclear device will be detonated in the Salado Formation. The top of the formation at the Gnome site is about 700 feet below the land surface and the formation is about 1,500 feet thick. Potash ore is not present at the Gnome site.

1.20

21.70

Gypsum of the middle member, <sup>the Tamarisk,</sup> of the Rustler Formation crops out on the left side of the road and around the edges of a playa lake on the right side of the road. Note slumped and draped appearance due to hydration and collapse toward the playa.

Cumulative  
Mileage

23.40 To the RIGHT is NASH WELL. This is one of the oldest wells in this vicinity. It is a well known landmark and is noted on most maps of the area. It is 30 feet deep and water stands within a few feet of the surface. The water is highly mineralized and is used only for livestock.

2.00

25.40 Junction with access road to Gnome site. This access road to the site may be closed a few days before the shot day, during the shot day, and for some days after shot day to visitors. Inquiry should be made at the AEC office in Carlsbad as to access to the site during this period. See item under 25.40+ for general instructions to official observers on shot day.

25.40+ (SPECIAL FOR OFFICIAL OBSERVERS ON SHOT DAY ONLY) Junction with road to observation post (Control Point) is about 200 feet east of the Gnome access road. Turn right (south) on this road which leads to the parking area and Control Point. Announcements will be made regarding details for parking on shot day.

NATURE NOTE: During the spring, summer, and fall months it is common to see specimens of certain local wildlife on and along this road. The long, dark-colored ones are Western Diamond-back rattlesnakes which attain a length of about 7 feet. The smaller (2 feet or so) light-brown ones are Prairie rattlesnakes. Both of these are poisonous. Nonpoisonous snakes noted are the so-called "brown racers" which are long, slender, light tan in color, and move quite rapidly and "bull snakes" which are heavier than the "racers" and at first startled glance resemble a Prairie rattlesnake. This area is particularly hospitable to this type of wildlife because the sinkholes in the gypsum offer cozy homes, the relative isolation offers peace and quiet, and the teeming population of Kangaroo rats affords adequate dining facilities.  
WATCH YOUR STEP!

Cumulative  
Mileage

Log continues to Gnome site.

- 25.40 Junction with access road to Gnome site. Turn right and continue SOUTH on unpaved road to Gnome site.

0.40

- 25.80 Control and observation posts for Project Gnome event to the left.

The road and control posts are surfaced with caliche which has been obtained from nearby borrow pits. Caliche forms calcareous zones in soil and near-surface deposits. It occurs at or just beneath the sand over most of this general area. It is similiar to limestone; however it contains sand grains and rock fragments. It becomes very hard when long exposed to weathering; where it is covered it is often soft and friable.

The red-brown sand which covers most of the land surface here, and forms conspicuous dunes in places, is known as the Mescalero sands. The sands are wind-blown and form an almost continuous cover over most of the land surface on the east side of the Pecos River in an area about 30 miles wide and extending many tens of miles northward from the Texas boundary. Some of the largest dunes are as much as 100 feet thick.

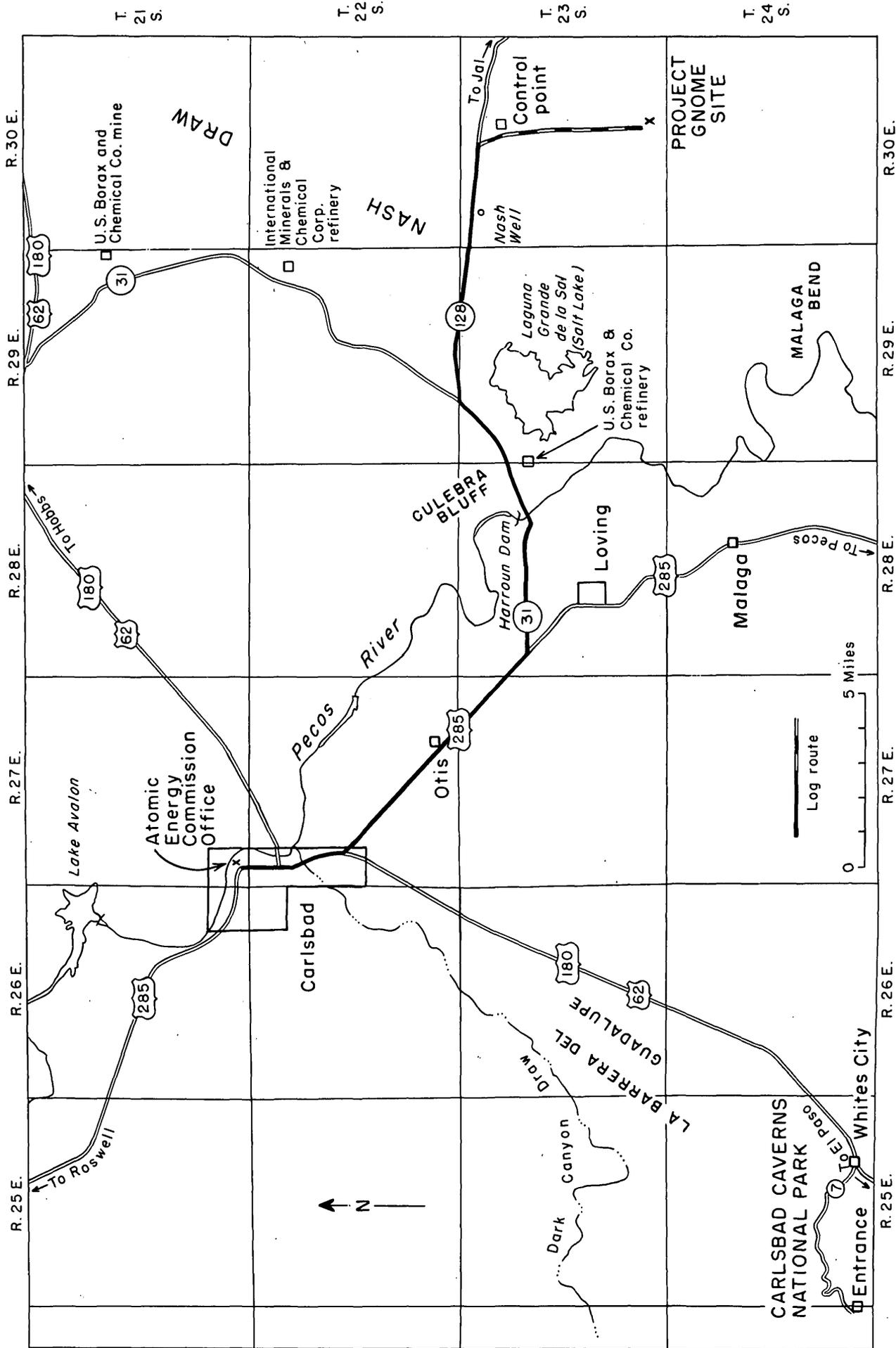
The Project Gnome site is located on the James Ranch. In common with most land in this section of the state, the land is actually owned by the Federal Government; it is leased to ranchers for cattle raising. The James family were early settlers in this area and have been actively engaged in ranching this land since the 1880's. Their holdings, including leased land, extends many miles eastward from Nash Draw.

4.10

- 29.90 Cattle guard in fence line. This fence marks the north line of sec. 34, T. 23 S., R. 30 E., Eddy County. The site of Project Gnome is near the center of this section. The fence was erected by the Atomic Energy Commission to outline the area being used for this experiment and to exclude livestock from the site.

0.50

- 30.40 Project Gnome shaft.



Route map -- Carlsbad to Project Gnome

## Geographic Setting of the Gnome Site Area

The Gnome site is in the Pecos Valley of southeastern New Mexico, 25 miles southeast of Carlsbad.

The Pecos Valley is a section of the Great Plains physiographic province. The Pecos River flows through the southwestern part of the area and divides it physiographically into the Mescalero pediment east of the river (the primary area of interest), and the alluvial plain north of Malaga and the Gypsum Hills south of Malaga, both west of the river.

The surface in the Gnome site area contains numerous depressions ranging in width from a few tens of feet to about 5 miles. Nash Draw, the largest depression in the area, extends southward through the area and terminates near Loving and Malaga. Within Nash Draw are several smaller depressions, the largest of which is Laguna Grande de la Sal (Salt Lake). Much of the Mescalero pediment is mantled by dune sands, but in places on the upland surface caliche is exposed, and elsewhere older formations crop out.

The climate of the area is semiarid. The average annual precipitation is about 13 inches. The winters are generally mild and the average annual temperature in January is about 40°F. Summers are quite warm. The average temperature in July is slightly higher than 80°F.

Six companies are in operation in the mining and refining of potash. The potash mines are east of the Pecos River and north of Gnome site. Workings of the International Mineral and Chemical Corp. extend to within about 8 miles of the Gnome site.

The nearest petroleum production to the Gnome site is the Texaco Inc. No. 1 Remuda Basin Unit, about  $4\frac{1}{2}$  miles northwest of the site. The Shell Oil Co. No. 1 James Ranch gas well is about 6 miles northeast, and the Richardson and Bass No. 1 Federal-Legg Oil well is about  $7\frac{1}{4}$  miles north.

About 30,000 acres in the area around and south of Carlsbad and mostly west of the Pecos River is irrigated by water diverted from the Pecos and Black Rivers and from ground-water sources, of which 20,000 acres is in the Carlsbad Irrigation District. All the lands are in the Carlsbad Declared Underground Water Basin which is administered by the New Mexico State Engineer Office.

The famous Carlsbad Caverns are about  $3\frac{1}{4}$  miles west and slightly south of the Gnome site. The caverns are in the Guadalupe Mountains--a great eastward-tilted block of the earth's crust more than 100 miles long and about half as wide.

## The Geologic Setting

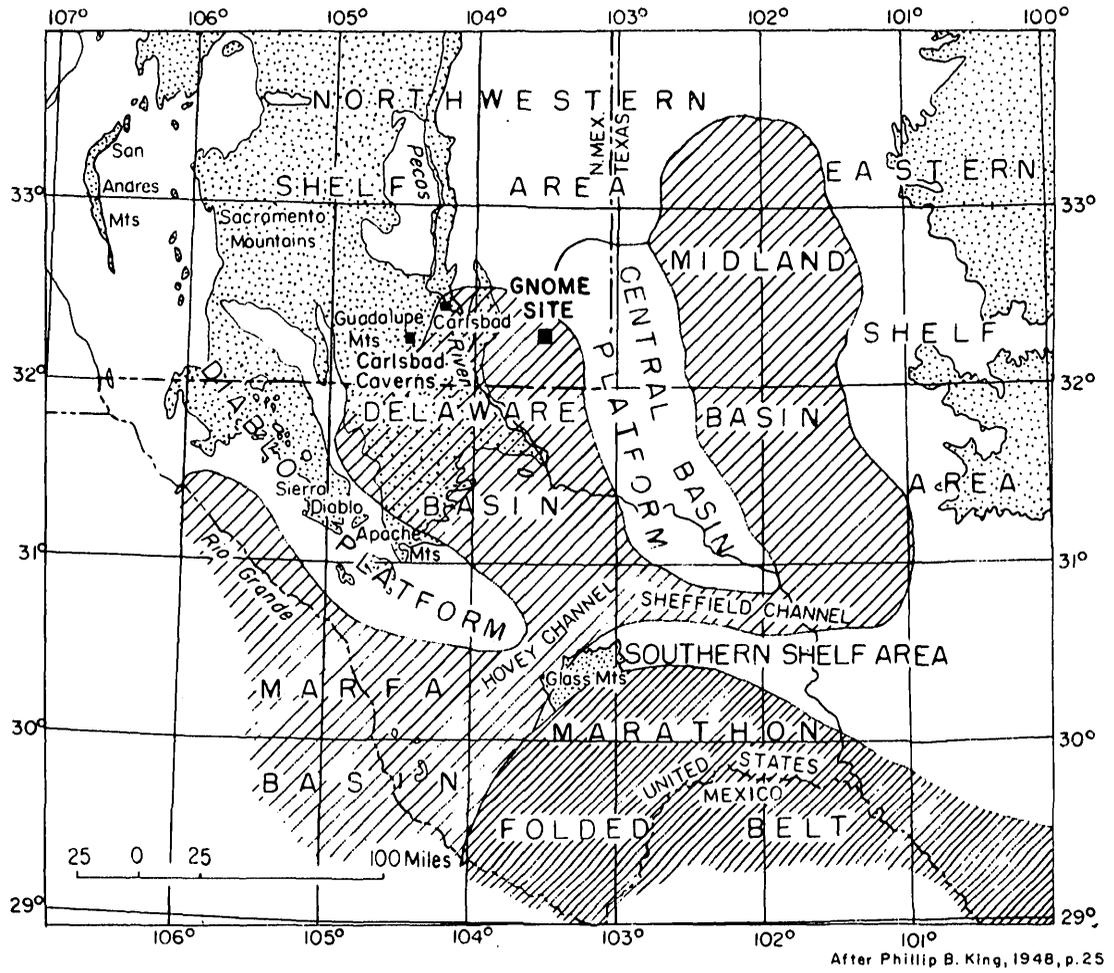
Southeastern New Mexico and adjacent parts of Texas were submerged beneath the sea in Permian time (during the period 180 to 205 million years ago). The irregular floor of the sea was characterized by structural basins, platforms, and broad shelves. (See illustration, p. 12.) The Gnome site is in the northeastern part of a deep Permian structural basin, known as the Delaware basin, which is 135 miles long and 75 miles wide.

Each Permian structural province received characteristic types of sediments. Fine sand and limestone accumulated in the basins; reefs formed on the margins of the shelves and platforms; limestone and sand accumulated immediately behind the landward side of the reefs; and gypsum, anhydrite, other evaporite rocks, silt, and clay accumulated in the shallow waters of the shelves. Eventually, the reef growth was halted by increasing salinity of the sea water and evaporite rocks (Castile, Salado, and Rustler Formations) were deposited in the Delaware basin. Evaporite deposition was interrupted during two intervals of time, during which the water was less saline and limestone was deposited. Deposition of the evaporite rocks ceased, and deposition of terrestrial red beds (Pierce Canyon Redbeds) began towards the end of Permian time. Terrestrial deposition continued during parts of Triassic time (during the period 150 to 180 million years ago). Additional thin deposits of sediments accumulated in Quaternary time. A total of 18,500 feet of sedimentary material, including pre-Permian sedimentary rocks, was deposited in the Delaware basin.

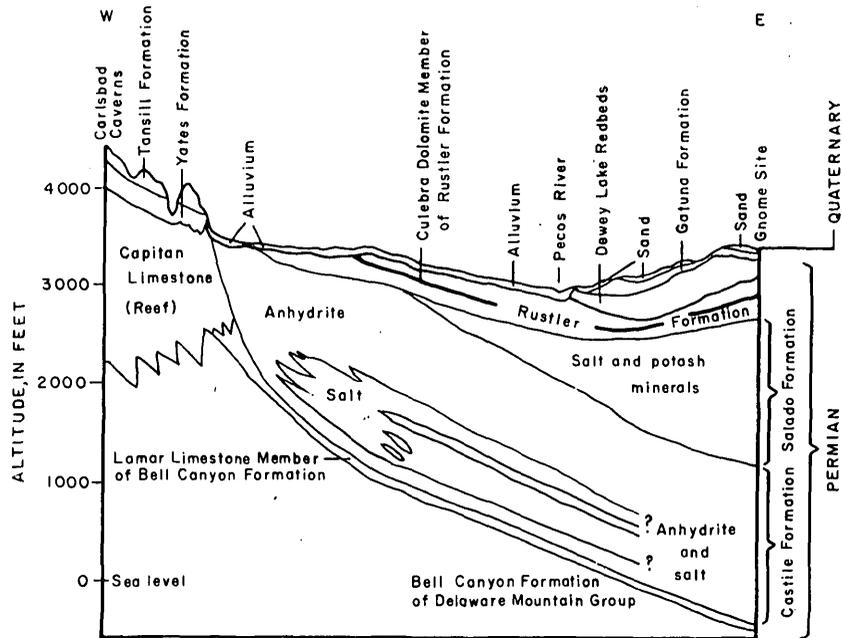
The Delaware basin is bordered on the west, north, and east by the Capitan reef which is represented by the Capitan Limestone of Permian age. The south side of the basin is bordered also by discontinuous reefs. The Capitan Limestone reef extends in the subsurface from Carlsbad eastward nearly to Hobbs and thence southeastward into Texas. West and southwest of Carlsbad the Capitan Limestone is at the surface and forms "La Barrera del Guadalupe" and El Capitan Peak. Large caverns--notably Carlsbad Caverns--were formed in the reef limestone through the solvent action of circulating ground water.

The Capitan Limestone is one of the principal fresh-water aquifers in southeastern New Mexico. The alluvium (sand and gravel) in the valley of the Pecos River also yields large supplies of fresh water. Large supplies of potable water are scarce or nonexistent in the Permian rocks within the Delaware basin.

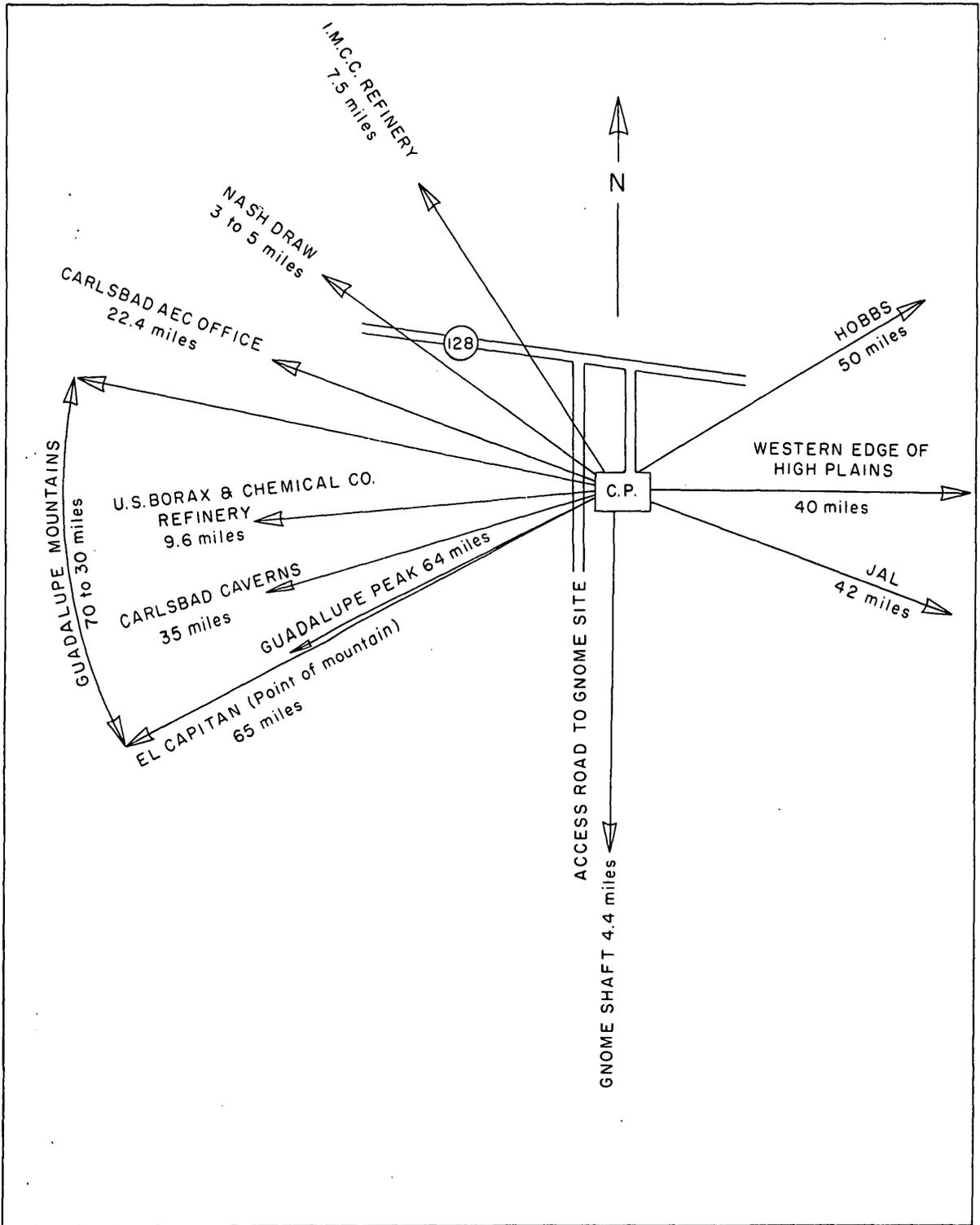
The evaporite rocks in the Delaware basin contain extensive deposits of potash minerals, which are mined at many localities and refined for potash fertilizers. Many wells produce oil from the reef limestone in southeastern New Mexico and western Texas. Oil and gas<sup>are</sup> produced also from some of the deeper formations in the Delaware basin.



Structural provinces during Permian time in southeastern New Mexico and west Texas. The wide-spaced slant lines delineate the basins, the close-spaced slant lines delineate the area of deformed pre-Permian rocks, the remaining areas are shelf and platform provinces. The stippled area delineates outcrops of Permian rocks independently of the provinces



Geologic section between Carlsbad Caverns National Park and Project Gnome site, N. Mex.



Orientation diagram at Control Point (C.P.), Project Gnome