MAP I-400

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC MAP AND SECTIONS OF THE TORRANCE STATION 4 NE QUADRANGLE, LINCOLN COUNTY, NEW MEXICO

By
W. A. Fischer and R. J. Hackman

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-400

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D.C.
1964

MAP I-400

GEOLOGIC MAP OF THE TORRANCE STATION 4 NE QUADRANGLE LINCOLN COUNTY, NEW MEXICO

by

William A. Fischer and Robert J. Hackman
U. S. Geological Survey

INTRODUCTION

The Torrance Station 4 NE quadrangle is in central New Mexico approximately 100 miles southeast of Albuquerque. This quadrangle was mapped as a part of the U. S. Geological Survey's investigations related to the usefulness of full color aerial photography in geologic mapping. Preliminary results of these investigations have been reported by Fischer (1958).

The town of Corona is the only settlement within the quadrangle and may be reached by U. S. Highway 54 or by New Mexico State Route 42. Preliminary field reconnaissance was undertaken in 1955, after which black-and-white photographs, at scales of 1:55,000 and 1:32,000, and a Kelsh plotter were used to prepare a preliminary geologic map of the quadrangle. This preliminary map was refined by the use of color photographs and subsequently used as supplementary data during the course of final field investigations in 1958 and 1959.

Geologic data were compiled on a topographic base map that was modified from the Army Map Service 1:250,000-scale quadrangle, Fort Sumner, New Mexico. Cultural and planimetric detail was added to the base map, contour lines were reshaped, and supplemental contours were plotted at 100-foot intervals. A Kelsh plotter and 1:55,000-scale black-and-white photographs (enlarged to approximately 1:11,000 scale on the plotter) were used to modify the base map.

Three aeromagnetic lines were flown across parts of the quadrangle in 1960. One of these lines followed Bonita Canyon, one northeast-trending line crossed the northwest corner of the area near U. S. Highway 54, and the third extended eastward from Corona. The results of the aeromagnetic survey were used to supplement and refine interpretations of stratigraphic thicknesses and structural setting.

The topography of the quadrangle is typical of the arid southwest, with steep canyons between numerous broad mesas that slope gently to the southeast. There are no permanent streams; the lowlands adjacent to Corona and most of the mesas are drained through the subsurface.

Iron, copper, and rare-earth deposits have been mined in an area immediately adjacent to the west boundary of this quadrangle (Kelley, 1947), but there has been no mining within the quadrangle.

GENERAL GEOLOGIC SETTING

The quadrangle is underlain primarily by sedimentary rocks of Permian age. The authors believe that these rocks were deposited as a foreland facies on Precambrian rocks. Subsequent folding, probably contemporaneous with Tertiary intrusions (Kelley, 1947) near the west margin of the quadrangle, resulted in an anticlinorium trending N. 40° E. Smaller folds resulting from solution and subsidence formed extensively on the flanks of the principal structural feature; subsidence folds are now prominently alined along a major direction of jointing, approximately parallel to the southeast regional dip.

Small sills of diabase intruded the sedimentary rocks, probably in Tertiary time.

STRATIGRAPHY

SEDIMENTARY ROCKS

The Yeso Formation (Wilpolt and others, 1946) is the oldest sedimentary formation in the quadrangle. It is overlain by the Glorieta Sandstone (Dane and Bachman, 1957) which is in turn overlain by the San Andres Limestone (Dane and Bachman, 1961). All are of Permian age. The thickness of sedimentary rocks exposed within the quadrangle totals approximately 400 feet. Aeromagnetic data (William J. Dempsey, oral communication, 1962) suggest that an additional 500 to 1,000 feet of sedimentary rocks overlies the basement beneath the floor of Bonita Canyon.

Yeso Formation

The Yeso Formation consists of four members (Wilpolt and others, 1946); only the two younger members, Cañas Gypsum (Pyc) and Joyita Sandstone (Pyj), are present within the quadrangle. The stratigraphic thickness of the two members exposed in the quadrangle is approximately 90 feet (columnar section 9). Near the Gallinas Mountains the thickness of the Yeso Formation is about 1,000 feet (Smith, 1957, p. 30). The limestone bed (15 feet) shown on columnar section 3 may be a part of the Torres Member (Wilpolt and others, 1946) of the Yeso Formation. However, as its relationship to the overlying rocks of the Cañas Gypsum Member is not clear, it is mapped as a part of the Cañas Gypsum Member.

Cañas Gypsum Member

The Cañas Gypsum Member is exposed in Bonita Canyon and at the base of the mesa that trends east from Corona. It is composed of white gypsum, medium and light-gray limestone (columnar sections 3, 9, and 10), and light-gray calcareous sandstone. The gypsum is predominantly massive; the limestone is thin bedded. Approximately 50 feet of these rocks is exposed in this quadrangle (columnar section 9). Because the lower part of the member is not exposed, the total thickness is not known, but it is as much as 105 feet thick in the southwestern part of Torrance County (Smith, 1957, p. 31).

Joyita Sandstone Member

The Joyita Sandstone Member of the Yeso Formation is exposed in Bonita Canyon and near the base of the mesa that trends east from Corona (columnar sections 2, 3, 6, 9, and 10). The Joyita Sandstone Member is composed of sandstone, silty sandstone, siltstone, and thin interbeds of claystone. The sandstones are commonly calcareous and many contain silt particles. Sandstones near the top of the section commonly weather to brown or red brown. The siltstones are also calcareous and weather to a bright yellow. The member is thin bedded. Many sandstone beds are separated by thin calcite layers. The Joyita Sandstone Member is 47 feet thick (columnar section 10).

Glorieta Sandstone

The Glorieta Sandstone forms the steep sides of mesas, underlies most of Bonita Canyon, and all of the canyon through which State Route 42 passes. It also crops out at the base of the east-trending mesa east of Corona and locally in the lowlands south and west of Corona. The Glorieta Sandstone is primarily composed of clean white permeable sandstone. Quartz grains are well rounded. Locally along the crests of sharp anticlines the Glorieta Sandstone is a deeper red than elsewhere and is silicified so that it breaks across the quartz grains. The upper part of the formation is calcareous, the lower part is generally noncalcareous. Sandstone beds are thick and commonly friable. The total thickness is approximately 275 feet (columnar sections 2, 9, and 10). Thickness measurements may be inaccurate, as erratic dips along the sides of the canyons suggest slumping. The Glorieta Sandstone as here mapped correlates with the lower clastic member of the San Andres Formation of Smith (1957).

Limestone bed within the Glorieta Sandstone

A limestone bed (Psl) is present locally within the Glorieta Sandstone in the southwestern part of the quadrangle (columnar section 2A). The limestone is medium gray and weathers to a similar color. Eastward in Bonita Canyon the limestone grades laterally into a calcareous sandstone. The limestone bed is 18 inches thick and is 110 feet stratigraphically below the base of the overlying San Andres Limestone.

San Andres Limestone

The San Andres Limestone caps the large mesas and underlies most of the lowlands south and west of Corona. It is composed almost entirely of medium-gray limestone. Locally along the bluff trending east from Corona, sandstone stringers and thin sandstone beds are present within the lower 12 feet of the San Andres. The limestones are thick bedded to massive, locally fossiliferous, and weather to scalloped forms. Fossils are poorly preserved and not diagnostic as to age (E. L. Yochelson, 1960, written communication). The maximum thickness of San Andres measured within this quadrangle is 47 feet (columnar section 2). The San Andres Limestone as here mapped correlates with the limestone member of the San Andres Formation of Smith (1957). The upper fine-grained clastic member of Smith (1957) is not present.

One small sill of fine-grained diabase (Tb) was observed near the northern edge of the quadrangle approximately 2-1/2 miles east of Corona (columnar sections 9 and 10). Aeromagnetic data (W. J. Dempsey, oral communication, 1962) suggest the presence of another igneous mass at or near the surface in the northwest part of the quadrangle in an area of poor outcrop, but this igneous rock was not observed in the field. The igneous rocks probably intruded the sediments in Tertiary time and may be related to the extensive Tertiary intrusions west of this quadrangle (Kelley, 1947).

SURFICIAL DEPOSITS

Surficial deposits are widespread in the quadrangle, primarily in the canyon and lowland areas, but also on the mesa. The floors of the canyons are covered with thick fine soils derived primarily from the Glorieta Sandstone. The sides of the canyons are largely covered with sandstone and limestone rubble. Areas of internal drainage are present in the lowlands areas south and east of Corona, and locally on top of the mesas; exceptionally thick residual soils occur in these areas. The areal distribution of these soils on the tops of the mesas was not mapped. Thick (5-10 feet) beds of caliche are in the surficial deposits in the lowlands south and east of Corona.

The distribution of igneous pebbles and Fragments in surficial deposits probably reflects the general course of drainages from the east flank of Gallinas Peak since at least Pleistocene time. Therefore, surficial deposits (Qi) that includes pebbles or fragments of igneous rock, primarily monzonite, are mapped separately from surficial deposits made up entirely of material derived from the sedimentary formations (Qal).

An area of half a square mile covered by small sand dunes (Qs) is located 3 miles east of Corona. The sand is composed of well-rounded quartz grains derived from the Glorieta Sandstone and is deposited on the surface of the San Andres Limestone. The sand was blown up the side of a steep, 250-foot high cliff that is normal to the prevailing wind direction. The trail of sand movement can be readily observed on the color aerial photographs, can be traced only with difficulty on the ground, and cannot be seen on black-and-white photographs.

STRUCTURE

The rocks in this quadrangle form a large anticlinorium; the axis trends approximately N. 40° E. and passes near the center of the quadrangle. A parallel synclinorium lies to the west between the western margin of the mapped area and the east flank of Gallinas Peak. Two types of structural features are superimposed on these major structures: tectonic folds, and small synclines and basins believed to have been formed by underground solution and subsequent subsidence. Anticlines and synclines believed to be of tectonic origin are symmetrical and trend approximately N. 40° E. The number and amplitude of the tectonic folds decrease to the east. These structures are probably related to igneous activity in the vicinity of Gallinas Peak (7 miles west of Corona) and Cerro Tecolote (10 miles southwest of the southwestern corner of the mapped area). The solution synclines and the basins are also symmetrical but contrast with the tectonic folds in that they are commonly smaller and their trough lines have a more-or-less random orientation. The solution structures themselves tend to be alined parallel to the joint set that most nearly parallels the direction of the regional dip (N. 45° W.); they are not shown on this map.

Folds shown on the map with dashed lines were mapped primarily from aerial photographs. The positions of the axes were inferred from 1) gross attitudes of outcrops on the rims of the mesas, 2) linear topographic highs, and 3) gross attitudes of rubble heaps on the mesas. These rubble heaps are composed of rock fragments believed to be only slightly out of place. The gross attitudes of these rock fragments are believed to represent structural attitudes. Most outcrops on the mesa tops are along streams or the periphery of sinkholes. All rocks near streams dip toward the streams; all rocks near sinkholes dip toward the centers of the sinkholes. These attitudes are caused by local subsidence. Because of these local effects of subsidence, it was not possible to map or confirm the position of the inferred fold axes in the field.

South and west of Corona, owing to numerous closed structures along the axes of tectonic folds, the anticlines form series of small alined domes and the synclines form series of small alined basins. A prominent secondary alinement nearly perpendicular to the main structural trend is readily observed on aerial photographs and in the field. This secondary alinement extends from a structural low of a tectonic syncline through a structural low of an adjacent tectonic anticline. The alinement is in a direction parallel to the joint set that most nearly parallels the direction of regional dip, and this suggests that the cross structures may have formed by subsidence after tectonic folding.

A large asymmetric tectonic anticline striking N. 30° E. approximately parallels the edge of the west-facing mesa south of Corona. Structural relief is approximately 300 feet on the west flank, approximately 50 feet on the east flank. The asymmetry of this fold contrasts with the general symmetry of other folds in the area. A large area of internal drainage parallels the base of the mesa and the trough of the syncline that lies immediately west of the anticline. There are several sinkholes near the trough of the syncline. The asymmetry of this fold and the area of internal drainage along the trough suggest that the west flank of the anticline may have been steepened by solution and subsequent subsidence.

The trough of the syncline that lies west of the large asymmetric anticline follows a sinuous path contrasting with the relatively straight trace of most of the tectonic axes. This sinuous path suggests that the position of the synclinal trough may have been shifted locally by subsidence resulting from solution. For this reason the trough expressed at the surface is interpreted on the map as a line of surface subsidence.

Two canyons, Bonita Canyon and the canyon through which State Route 42 passes, trend N. 45° W in contrast to tectonic structures which trend N. 40° E. These valleys were cut in subsidence synclines that have been superimposed on the tectonic structures by solution of material from beneath the canyon floor. Beds on the sides of the canyons strike in a direction parallel to the canyons (approximately normal to the major structural trend). Some minor folds parallel the canyons but in the main the rocks dip steeply into the canyons. The attitudes of the beds, the orientation of the valleys parallel to a prominent joint set (N. 45° W.) that most nearly trends in the direction of regional dip, and the fact that the stream channels within the canyons cross the axes of the major tectonic structures and are not deflected, suggest that these valleys were formed subsequent to the tectonic structures. They were probably formed by coalescing sinkholes and associated subsidence and may reflect paths of subterranean waters.

Large subcircular features (1 square mile in area) can be seen in the bottoms of the canyons, principally Bonita Canyon, on color aerial photographs. One of these subcircular areas, located near the bottom of Bonita Canyon approximately 1,000 feet from the canyon rim, has small angular blocks of limestone on its surface. The surface, however, is now more than 200 feet topographically below the base of the San Andres Limestone where exposed along the rim of the canyon. These features appear to be large relic sinkholes. Streams in the canyons tend to either flow around these features or pass directly across them without change in size or character.

Many sinkholes and areas of local subsidence are visible on the mesas. The canyon rims have been eroded back so that many of these sinkholes and areas of local subsidence have been breached and may be seen in cross section; in some of these breached features the San Andres Limestone has dropped more than 40 feet into the underlying Glorieta Sandstone. Because of local subsidence the contact between the San Andres Limestone and the Glorieta Sandstone rises and falls along the canyon rim. This undulation is expressed on the geologic map by seemingly erratic crossing and recrossing of topographic contours by the San Andres-Glorieta contact. Many dips shown on the tops of the mesas that seem inconsistent with tectonic structures reflect local subsidence.

Six small faults have been mapped within the quadrangle. The maximum vertical displacement along them is 6 feet. All these faults approximately parallel a joint set that trends generally N. 35° E. Some vertical or near vertical movement has taken place along many of the joint planes seen along the north side of Bonita Canyon. The maximum displacement observed was 2 inches. Several other joints trending approximately N. 30° E. show clearly on aerial photographs for distances of as much as 2 miles. These prominent joints are partly filled with banded chalcedony and terminated quartz crystals; there has been no measurable movement and they are here mapped as linear features.

GEOLOGIC HISTORY

The sedimentary rocks exposed within this quadrangle are a foreland facies probably deposited in a platform area in Permian time. Interbedded limestone, siltstone, sandstone, and gypsum imply fluctuating depositional conditions in Yeso time. The relatively thick clean sandstones that overlie the Yeso Formation indicate a change to relatively stable depositional conditions in early Glorieta time. The relatively noncalcareous sands of the Glorieta were clean, well sorted, and well rounded. They were probably subjected to much reworking and washing possibly in a near-shore or beach environment. The transition to conditions favorable for the deposition of the San Andres Limestone must have been relatively abrupt. The contact between the Glorieta and the San Andres is sharp, local relief on the surface of the Glorieta is small, and there are very few quartz grains visible in the basal part of the San Andres Limestone, except locally in the northwestern part of the quadrangle.

The intrusion of diabase into beds of the Yeso Formation is considered to have taken place at the same time as the volcanic activity in the neighboring Gallinas Mountains, in Tertiary time (Kelley, 1947). The northeast-trending folds were probably developed contemporaneously with or shortly after this period of volcanism.

The present gently undulating land surface and the sharp canyons have developed largely since Tertiary time, probably in later stages by underground solution and subsidence. The distribution of igneous material in the surficial materials, as here mapped, implies that surface drainage from the east side of the Gallinas Mountains has been in a southeasterly direction and in part through Bonita Canyon since at least Pleistocene time.

Bonita Canyon must have subsided to its present level in Recent time. Igneous pebbles along the south side of the canyon approximately 160 feet above the canyon floor would have been removed from the relatively steep side of the canyon during a long period of erosion.

REFERENCES

Dane, cC. H., and Bachman, G. O., 1957, Preliminary geologic map of the northwestern part of New Mexico: U. S. Geol. Survey Misc. Geol. Inv. Map I-224.

Dane, C. H., and Bachman, G. O., 1961, Preliminary geologic map of the southwestern part of New Mexico: U. S. Geol. Survey Misc. Geol. Inv. Map I-344.

Fischer, W. A., 1958, Color photography in photogeologic interpretation: Photogramm. Eng., v. 24, no. 4, p. 545-548.

Kelley, V. C., 1947, Geologic and topographic map of the eastern Gallinas Mountains, Lincoln County, New Mexico: U. S. Geol. Survey Strategic Minerals Inv. Prelim. Map 3-211.

Smith, R. E., 1957, Geology and ground-water resources of Torrance County, New Mexico: New Mexico Bur. Mines and Mineral Resources Ground Water Rept. 5.

Wilpolt, R. H., and others, 1946, Geologic map and stratigraphic sections of Paleozoic rocks of the Joyita Hills, Los Pinos Mountains, and northern Chupadera Mesa, Valencia, Torrance, and Socorro Counties, New Mexico: U. S. Geol. Survey Oil and Gas Inv. Prelim. Map 61.

38320