



Structure of the central Chama platform, northern Rio Arriba County, New Mexico

William R. Muehlberger

1960, pp. 103-109. <https://doi.org/10.56577/FFC-11.103>

in:

Rio Chama Country, Beaumont, E. C.; Read, C. B.; [eds.], New Mexico Geological Society 11th Annual Fall Field Conference Guidebook, 129 p. <https://doi.org/10.56577/FFC-11>

This is one of many related papers that were included in the 1960 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

STRUCTURE OF THE CENTRAL CHAMA PLATFORM, NORTHERN RIO ARriba COUNTY, NEW MEXICO*

WILLIAM R. MUEHLBERGER

The University of Texas

INTRODUCTION

The central Chama platform is a structural terrace separating the San Juan Basin on the west from the Brazos uplift on the east. The relatively stable platform has been faulted and folded, but on a very modest scale in comparison with the great flanking structures.

The stratigraphic details of most of the area under discussion are furnished in the companion article (Muehlberger, et al.) in this guidebook. This paper was written and illustrations were drafted while the author was in the field. As a result the bibliography cited is inadequate and represents the literature at hand. All the important regional studies of V. C. Kelley and others are missing, unfortunately.

In addition to the financial support given by the New Mexico Bureau of Mines and Mineral Resources, I gratefully acknowledge the financial aid received for various phases of this work from The Geology Foundation and the University Research Institute of The University of Texas.

Figure 1 summarizes the important structural features; figures 2 and 3 show details of representative areas; figure 4 shows diagrammatically an interesting transition between faulting and folding. The text furnishes a discussion of the structural features and their inferred origins.

CHAMA PLATFORM

The Chama platform (embayment or basin; see Kelley, 1950, p. 101, 102, 103 for all three usages) lies between the Archuleta anticlinorium on the west and the Brazos uplift on the east (figure 1). The Brazos uplift is represented by the Tusas Mountains, the continuation into New Mexico of the San Juan Mountains of Colorado. North and east from the Willow Creek fault zone, the Chama platform has only a few hundred feet of structural relief (see figure 3). South of the feature termed Brazos flaw on figure 1 the platform becomes broader, structural features trend more northerly, and are of a lesser intensity.

The margins of the Chama platform are difficult to define north of the Brazos flaw because the northwest-trending structures give the platform a serrated appearance. For example, if the Willow Creek, Azotea, and Chromo anticlines are used as the bounding structures of the Archuleta anticlinorium, then relatively structureless areas of the Chama platform extend northwest between the anticlines. The eastern margin of the Chama platform merges with the Brazos slope toward the Brazos uplift.

The Dos Lomas anticlines (fig. 3) are a group of narrow, sharp-crested faulted anticlines along the crest of a broad low dome between the Chama syncline and the Azotea fault zone. El Cerro dome, with 500 feet of structural relief, is faulted along both the north and south flanks, and is a tight fold in the Dakota formation. Probably it is relatively flat and open in the Entrada formation due to flowage of the intervening incompetent Morrison shale.

South of the Brazos flaw, the Chama platform opens out into a broad synclinal basin. East of the trough of the

Chama syncline, the Mesozoic rocks rise on the Brazos without any significant interruptions to the vicinity of El Rito Creek (unpublished studies by H. H. Doney, 1955-1957). West of the trough, the floor of the Chama platform is broken by minor north-trending faults and folds. North and South El Vado domes form the west border of the platform. These positive features are typical of the region in that they are abruptly and sharply deformed in contrast to the relatively undisturbed areas surrounding them. All the folds appear to rise above the level of the region along the sharply defined margins in such a manner that the intervening synclines are nearly flat-bottomed or, by some definitions, non-existent.

BRAZOS FLAW

The Brazos flaw is a narrow zone of structural dislocation trending slightly north of west that is traceable from the south rim of the Brazos Box westward to Horse Lake, a distance of about 30 miles. The westward extension as indicated by the structure contouring of Dane (1948) then turns slightly more northerly and continues for another 10 miles down Cordova Canyon to a point about one mile south of Dulce Lake. The eastward extension passes through Hopewell Lake and loses its character in the Jawbone Mountains and Tusas Mountain Precambrian highlands. With the recognizable extension, the Brazos flaw may be postulated for a distance of about 50 miles.

The structural significance of the Brazos flaw can best be seen on figure 1. North of the zone, most of the folds and fault zones trend northwest. South of it, the dominant trend is nearly due north and the amount and intensity of deformation appears to be significantly less. This apparent intensity may be due in part to the fact that no detailed geologic mapping is available for the southeastern part of the Tierra Amarilla quadrangle. Wells drilled to the south of the Brazos flaw penetrate thin sections of Paleozoic rocks beneath the Triassic before reaching Precambrian rocks. North of the flaw in New Mexico, the few wells reaching basement have encountered no Paleozoic rocks beneath the Triassic (data from unpublished compilation by Roy Foster, New Mexico Bureau of Mines and Mineral Resources). On the other hand, the only outcrop of Paleozoic rocks in this region lies about 2 miles north of the Brazos flaw in Chavez Canyon at the foot of the Tusas Mountains. The presence of Permian rocks on the outcrop along the southeast rim of the Chama basin (see article by Smith, et al., this guidebook), and Pennsylvanian in wells south of the Brazos flaw and in the outcrop immediately north of the Brazos flaw, suggest a northward truncation of units prior to Triassic deposition and thus the possibility of stratigraphic traps associated with the unconformity.

The Brazos flaw appears to be a feature along which there has been recurrent activity and is controlled by Precambrian stratigraphy and structure. Major northwest-trending folds and faults in the Precambrian units turn west along the flaw just east of the Brazos Box. When traced further, they again turn northwestward before plunging under the cover of the Mesozoic rocks near Chama. Pre-Triassic deformation along this zone appears to be likely.

(*Publication authorized by Director, New Mexico Bureau of Mines & Mineral Resources, Socorro)

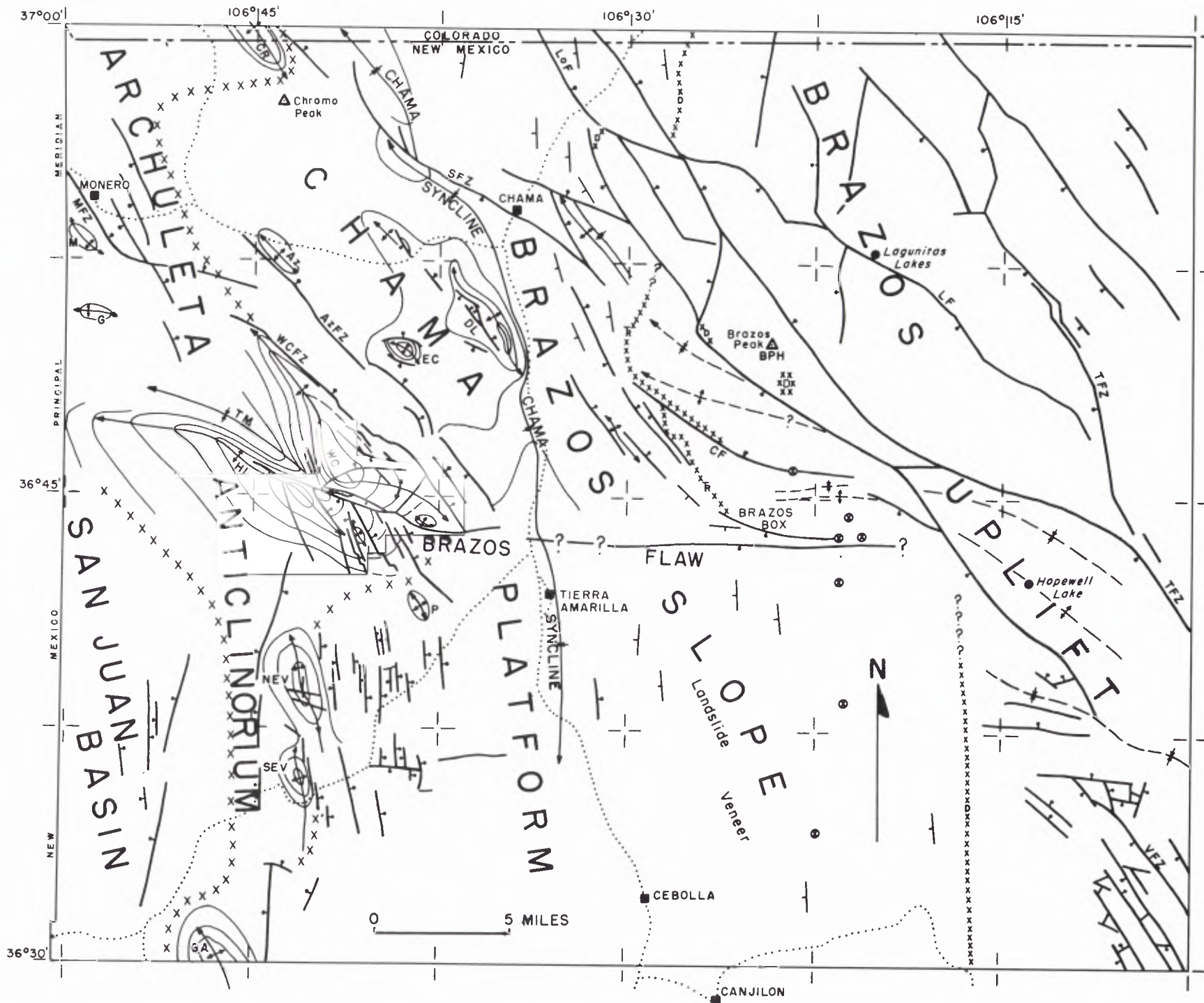







FIGURE 1. Structural features of central Chama platform and adjacent regions. Compiled from geologic maps by G. E. Adams (1957), Fred Barker (1948), A. P. Butler, Jr. (1946), C. H. Dane (1948), J. H. Davis (1960), H. H. Doney (unpublished), T. E. Longgood, Jr. (1960), B. E. St. John (1960) E. L. Trice, Jr. (1957), and W. R. Muehlberger (unpublished).

EXPLANATION

- x x x x x Principal structural subdivisions
- xxxxxxxdx East boundary of Brazos slope where marked by outcrop of Dakota formation
- xxxxxxRxxx East boundary of Brazos slope where marked by outcrop of Triassic rocks; ? where uncertain
(West boundary of Brazos slope coincides with Chama syncline)
-  Fault; * indicates downthrown side
-  Anticlinal axis
-  Synclinal axis
-  Structural form lines
-  Volcanoes of Quaternary age
- Highway

ABBREVIATIONS

- Archuleta anticlinorium
- MFZ Monero fault zone
- M Monero dome
- G Garcia dome
- WCFZ Willow Creek fault zone
- WC Willow Creek anticline
- TM Tecolote Mesa syncline
- HL Horse Lake anticline
- L Laguna dome
- NEV North El Vado dome
- SEV South El Vado dome
- GA Gallina anticline
- Chama platform
- Az Azotea anticline
- AzFZ Azotea fault zone
- EC El Cerro dome
- DL Dos Lomas anticline
- P Puente dome
- Brazos slope
- LoF Lobato fault
- SFZ Sargent fault zone
- Brazos uplift
- LF Lagunitas fault
- TFZ Tusas fault zone
- BPH Brazos Peak horst
- CF Chavez fault
- VFZ Vallecitos fault zone

Laramide displacements are delineated in figure 2 which shows the structure of the Horse Lake-Willow Creek region. This region straddles the Brazos flow in the area of maximum exposures. Late Pleistocene activity is indicated by the concentration of early Wisconsin age volcanoes along the eastern end of the Brazos flow (fig. 1).

BRAZOS SLOPE

The Brazos slope is used herein for the region east of the trough of the Chama syncline and west of the outcroppings of Triassic rocks to the north of the Brazos flow. Where the Triassic rocks are buried by Cenozoic rocks, the east boundary is marked by the outcrop of the Dakota formation. In places this eastern boundary is inferred owing to the presence of post-Laramide rocks on the Brazos uplift. The dip of the strata on the Brazos slope increases away from the trough of the Chama syncline. West of the Chavez fault the Dakota and Entrada are nearly vertical. On the down-thrown east side of the Chavez fault, the preserved Chinle formation dips westward at angles of less than 25 degrees. Farther east, at the west edge of the Brazos Peak horst (fig. 1), the preserved remnants of Dakota have two distinct structural attitudes. The northern remnant is vertical, with the upper side to the west, whereas the southern remnant dips about 10 degrees to the southwest. Along the uparched front, the Laramide faults are dominantly downthrown to the east in contrast to the late Tertiary faults which are dominantly downthrown to the west. Just north of the Brazos box in a distance of two miles the Mesozoic rocks rise nearly 5,000 feet from the trough of the Chama syncline to the elevation of their eroded edges. These strata can be presumed to have been present at even higher elevations. North of the Sargent fault zone a like amount of structural relief continues into southern Colorado but gentler dips and faults widen the zone of uplift.

An interesting transition between faults in the Precambrian quartzite and the overlying Mesozoic sedimentary rocks can be traced across the upper part of the Chavez box. The relations are shown in figure 4. Two parallel faults bound a block downthrown 150 feet (not a graben because both faults dip steeply east). The overlying 500 feet of Triassic Chinle is covered and the Entrada formation is the next unit that can be studied on the outcrop. The Entrada dips into the downthrown block along myriad closely-spaced joints that are parallel to the underlying faults. The 500-foot thickness of the Morrison formation, the next higher stratigraphic unit, is covered and the Dakota sandstone is the next higher unit that can be studied. The Dakota, although jointed, is folded into the trough between the faults. Thus the brittle units change deformational character upwards from faulting to close-spaced jointing to folding with minor jointing as the intervening soft, plastic formations distribute the deformation over a wider zone.

BRAZOS UPLIFT

The topographically and structurally high Tusas Mountains, the southeast extension of the San Juan Mountains into northern New Mexico, constitute the visible expression of the Brazos uplift. This area has been structurally high at repeated intervals from at least the time of late Paleozoic deposition, as is shown by a coarsening of stratigraphic units, wedging, and overlap relations onto the Precambrian surface. The periods of uplift are interpreted to have occurred during the time of deposition of the following units: (1) unnamed Pennsylvanian unit of Des Moines age; (2) post-Cutler pre-Chinle (period of erosion); (3) Chinle; (4) Entrada; (5) Dakota(?); (6) Animas; (7) Blanco

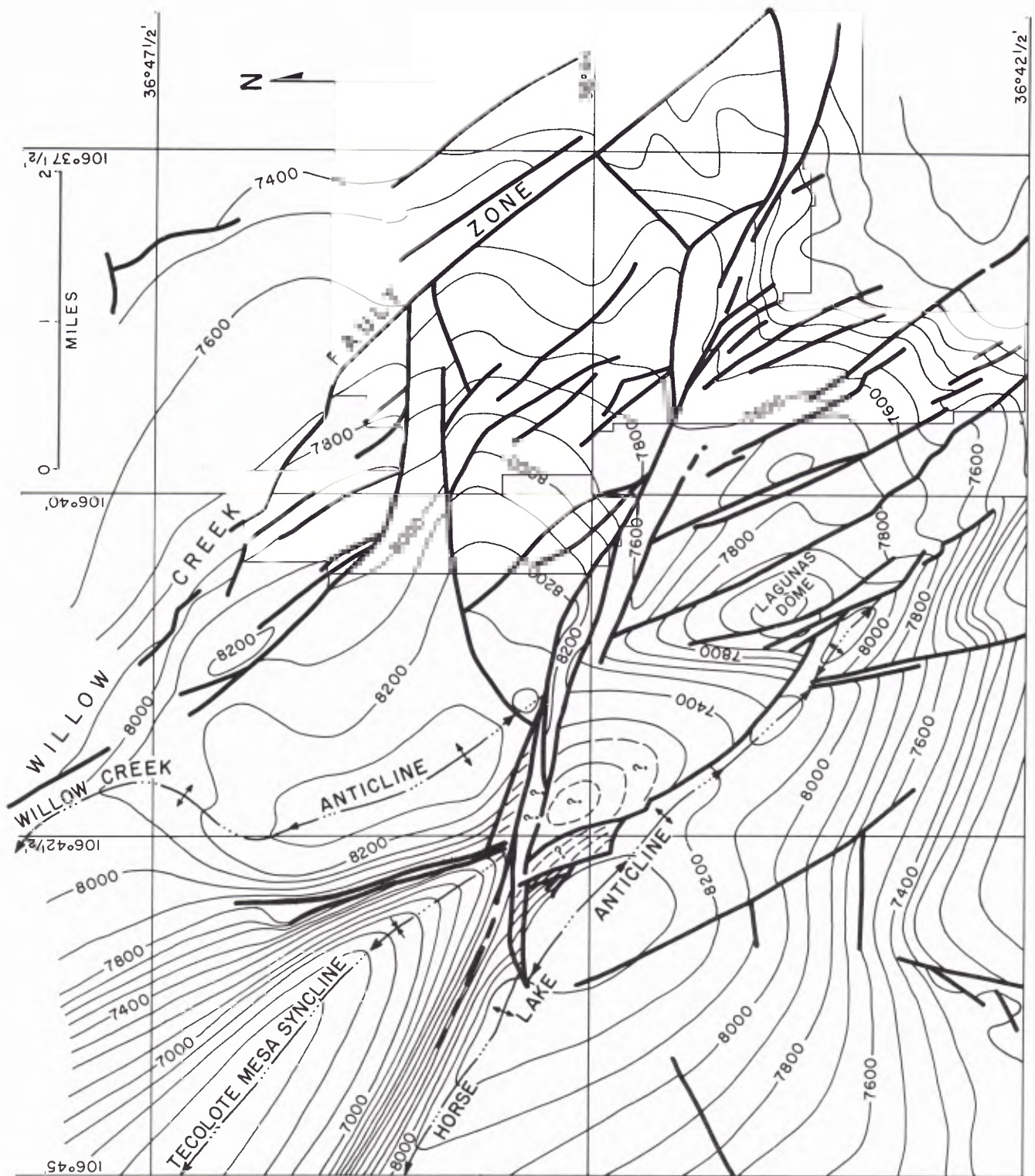


FIGURE 2. Structure contour map of the Willow Creek and Horse Lake anticlines showing the main structural features of the Archuleta anticlinorium in northern New Mexico. The Brazos fault is represented by the belt of west-northwest-trending faults near the center of the map. Contours drawn at 100-foot intervals on top of the Greenhorn limestone member of the Mancos formation. Modified from J. H. Davis (1960) and B. E. St. John (1960).

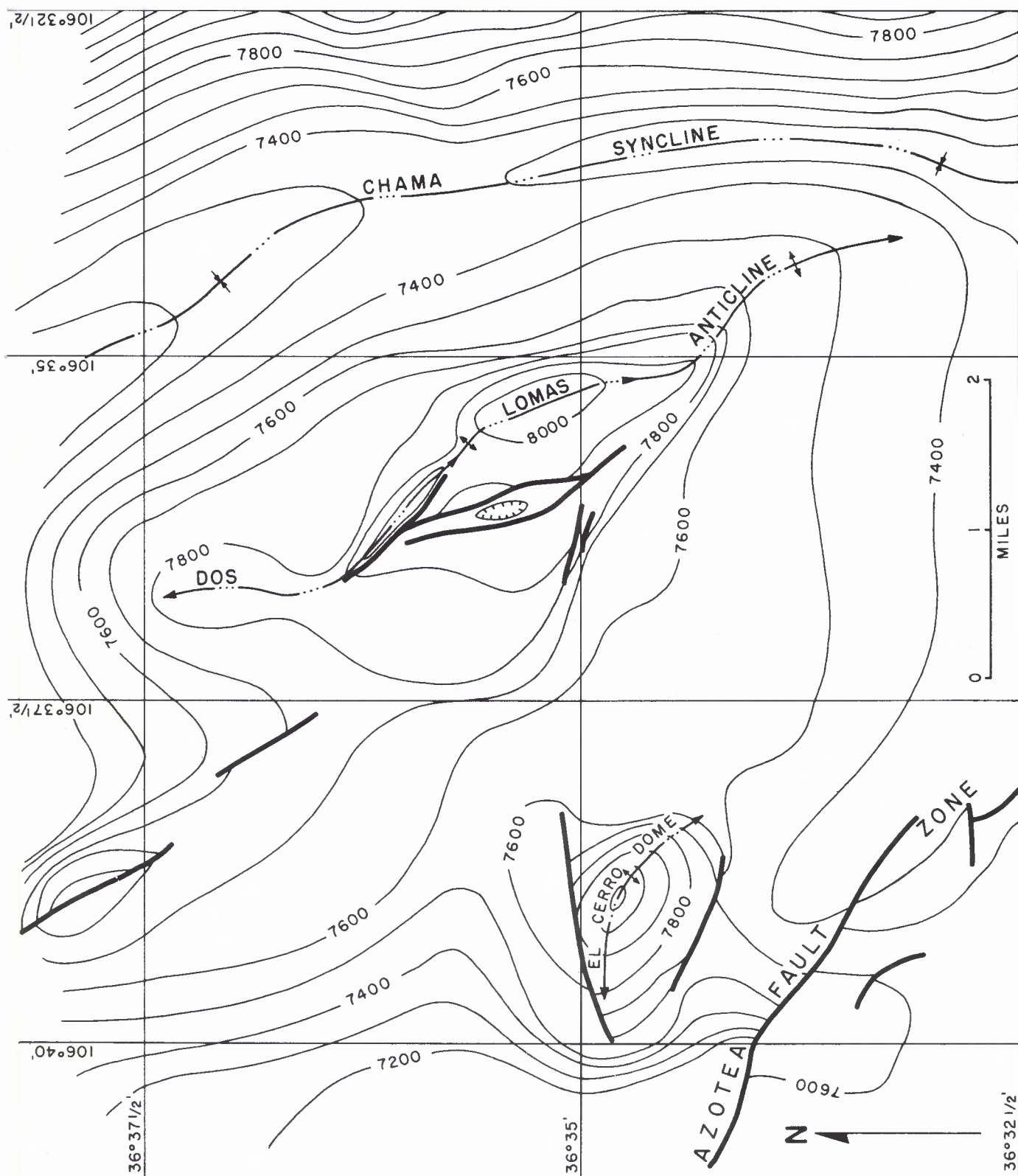


FIGURE 3. Structure contour map of the central Chama platform. El Cerro dome and Dos Lomas anticlines are decollement uplifts on the broad arch between the Azotea fault zone and the Chama syncline. Contours drawn at 100-foot intervals on top of the Greenhorn limestone member of the Mancos formation. Modified in part from T. E. Longgood, Jr. (1960) and B. E. St. John (1960).

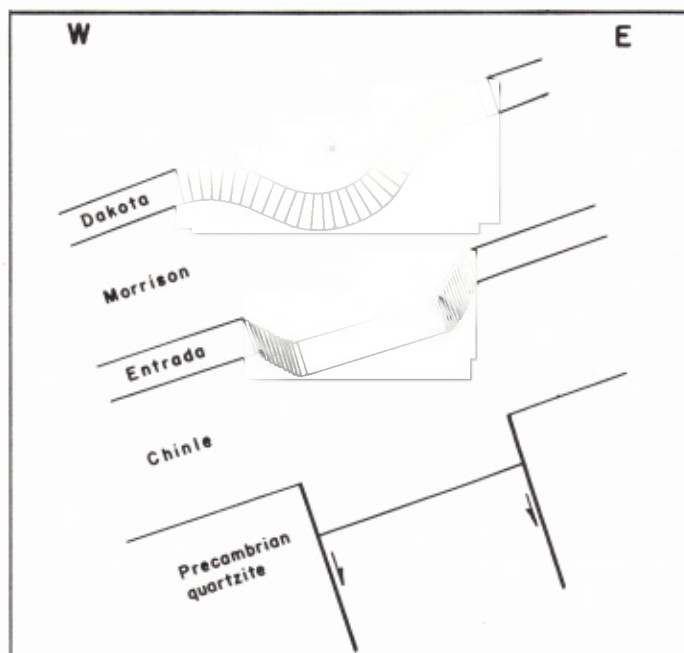


FIGURE 4. Diagrammatic view near the head of Chavez Box showing the transition from faulting in the Precambrian quartzite through closely spaced jointing in the Entrada formation to folding in the Dakota formation.

Basin - El Rito; (8) volcanic and clastic units of middle and late Tertiary age; and (9) Quaternary. In addition, downwarping elsewhere might be interpreted as gentle uplift here (viz., the basal Niobrara unconformity of Dane, 1960).

The rock units of the Tusas Mountains today consist of two parallel belts of Precambrian rocks, in part covered by Tertiary volcanic and continental clastic rocks and Quaternary glacial and landslide deposits. Any Paleozoic or Mesozoic rocks that may have been present originally were eroded prior to the deposition of the basal Tertiary formations (Blanco Basin north of $36^{\circ} 50'$ and El Rito of possible Eocene age), except for the small Dakota outcrops along the west base of the Brazos Peak horst.

The structure of the Brazos uplift today is dominated by long fault zones usually with throws averaging less than 1,000 feet. The throw may be as much as 1,600 feet but in most places it is less than 600 feet. Individual fault zones have been traced for distances up to 30 miles. The main faults trend northwest with smaller cross faults of north or west trends (as shown earlier by Butler, 1946 and Barker, 1958, for the eastern Tusas Mountains).

The late Tertiary movements along these zones uplifted the east side. This, combined with the late Tertiary eastward tilting of the region, keeps the few volcanic marker beds at the surface, thus aiding in the delineation of the faults. Butler (1946, fig. 29) was able to demonstrate at least two movements on the Tusas fault zone in the late Tertiary. Along the Brazos slope where older Tertiary and Mesozoic rocks are exposed, several other periods of faulting can be outlined. Along the Lobato fault near the intersection of the Chama River and Lobato Creek (northeast of Chama), Laramide displacements dropped the east side more than 1,000 feet (upper Morrison against the lower part of the upper Mancos shale), whereas the Tertiary units

overlying the truncated Mesozoic units have been dropped 100 feet on the west (Adams, p. 68, 1957). Along the same fault zone, 10 miles southeast, the Brazos Peak horst (BPH, fig. 1) has been raised 1,500 feet above the level of the surrounding Tertiary rocks.

The Lagunitas fault is typical of the Tusas Mountains. It extends northwest from its junction with the Tusas fault zone near Brokeoff Mountain (Butler, 1946) across the Brazos Peak quadrangle, a distance of 25 miles before it enters Colorado along the Chama River. Rapid changes in throw occur along the strike. For example, the displacement varies from 600 feet at Lagunitas Lakes, to only a few feet less than two miles further southeast. Northwest of Lagunitas Lakes the fault continues with throws ranging between 200 and 600 feet except for the west-trending segments where it forms a slightly faulted monocline that is downthrown on the south. Throughout its mapped length the west and south sides are downthrown. Throw on the Lagunitas fault changes abruptly in an amount equal to the throw of the smaller faults where they terminate against it.

ARCHULETA ANTICLINORIUM

Wood et al (1948) defined the Archuleta anticlinorium as the structural divide that separates the San Juan Basin from the Chama basin. This structural divide is the northward continuation of the Nacimiento and San Pedro Mountain uplifts of New Mexico. The monoclinical fold which rims much of the San Juan Basin is interrupted in this area by the complex of folds and faults constituting the Archuleta anticlinorium.

In Colorado the Boone Creek and Chromo anticlines mark the east side of the Archuleta anticlinorium and the Newton Mesa and Montezuma anticlines mark the west side (Wood et al, 1948). These belts of anticlines are separated by the Klutter Mountain syncline.

In New Mexico the relations are not as clearly defined. The continuation of the eastern belt of deformation might be construed to be represented by the small faulted anticlines here named the Dos Lomas anticlines, although these are included here in the Chama platform (fig. 1). The western belt is defined by the fault zone that passes through Lumberton and Monero. In this belt also occur Monero dome and the Willow Creek anticline on the north side of the Brazos flaw. South of the Brazos flaw only a single line of structures mark the Archuleta anticlinorium. Horse Lake anticline, North El Vado Dome, and South El Vado dome form the northern part of the structural rim. The Gallina and French Mesa anticlines form the southern part that is parallel to, but several miles west of the northern line of anticlines. The Willow Creek and Horse Lake anticlines (fig. 2), in addition to being a part of the Archuleta anticlinorium, mark the position of the Brazos flaw. The Willow Creek anticline is broad and flat-topped with a gentle east flank. The west flank plunges steeply into the Tecolote Mesa syncline. Northeast of the Willow Creek fault zone, the rocks are nearly flat. The Horse Lake anticline is also highly asymmetrical with a gentle south flank and a steep north flank. The Lagunas dome resembles the Willow Creek anticline except that it is smaller and broken by more longitudinal faults. The anticlines are all highly faulted because erosion has exposed the top of the Dakota formation, a brittle unit that has a well-developed fracture pattern. Most of the faults are nearly vertical and small in throw. They may, however, be traced for several miles. The dominant joint set is parallel to the faults, and in places a subordinate set is normal thereto. Elsewhere the subordinate

joint directions comprise a conjugate pair of shear joint sets whose acute bisectrix includes the prominent joint direction (see J. H. Davis, 1960 map). The Tecolote Mesa syncline is shown without faults. This is probably due to the masking effect of the nearly continuous cover of landslide debris below the Mesaverde which caps Tecolote Mesa. The steep flank between Horse Lake anticline and Tecolote Mesa syncline is probably faulted. This is especially likely inasmuch as it marks the trace of the Brazos flaw in this area. The trough west of the Lagunas dome might be interpreted as part of the Tecolote Mesa syncline but the presence of the major faults along the Brazos flaw suggests it had an independent origin although comparable position during the development of the main anticlinal structures.

ORIGIN OF STRUCTURES

The observed structural features in the Chama platform and Archuleta anticlinorium in northern New Mexico are the result of Laramide deformation with later Cenozoic accentuation. These features appear to be superposed on Precambrian and late Paleozoic structural trends.

In the Brazos uplift the late Cenozoic and older faults parallel the trend of the Precambrian structures. This is best shown on the map of the Las Tablas quadrangle (Barker, 1958) and in the region of the Brazos box. In the latter area the fold axes in the Precambrian quartzite and the late Cenozoic folds both trend more westerly than those of the adjacent areas.

The late Paleozoic trends probably reflect reactivation of Precambrian structural trends. Kelley (1950, p. 105) suggested probable Precambrian control although it was not then demonstrable. The mapping by Barker (1958), Doney (unpublished), Trice (1957), and the writer shows that the Precambrian structural grain in the Brazos uplift is parallel to all later major structural features. The trends of the major fault zones and folds of the Archuleta anticlinorium and the Chama platform parallel those in the adjacent Brazos uplift. Thus they probably reflect faulting at depth in the Precambrian rocks.

The Chama platform is essentially a structural terrace between the San Juan Basin to the west and the Brazos uplift to the east. The Archuleta anticlinorium lies along the western edge of the structural terrace and consists of a group of uplifts rising above the regional norm. The oversteepened west flanks of the Willow Creek anticline, Lagunas dome, and the North and South El Vado domes suggest a westward gliding of the Dakota formation and overlying units over the older sedimentary rocks. Without this westward decollement the formations should roll over into the San Juan Basin without any uplift along the edge of the platform. On a smaller scale, El Cerro dome, the Dos Lomas anticlines, and the tight folds in Little Willow Creek

east of Chama, appear to be similar decollement structures. The Chromo anticline is asymmetrical to the east and is on the eastern flank of the Archuleta anticlinorium in southern Colorado. This eastward overturning could be accomplished by further westward decollement movement under the fold which would tend to pinch it off at depth. Possibly the amount of decollement uplift should be measured from the trough of the Klutter Mountain syncline to the crest of the adjacent anticlines (4,000 feet as measured on the base of the Mesaverde group, from Wood et al, 1948).

The driving force which caused the decollement folding can be interpreted to have been due to the weight of the sedimentary rocks in the more than 5,000 feet of structural relief of the Brazos slope. Thick sequences of incompetent beds separated by competent beds form an excellent stratigraphic framework for decollement and disharmonic folding.

The late Cenozoic eastward tilting and up-to-the-east faulting of the Brazos uplift is probably the result of the downdropping of the Rio Grande depression (Butler, 1946, p. 168). How far west the eastward tilting continued into the Chama platform is not known because of the erosional stripping of the Cenozoic rock cover. If it continued across the Chama platform, the Chama platform prior to the eastward tilting would no longer have a Chama syncline marking the edge of the Brazos slope but would only have a change in the regional westward dip at that point.

REFERENCES

- Adams, G. E., 1957, *Geology of the Chama area, Rio Arriba County, New Mexico*: unpub. M. A. thesis, The Univ. of Texas, Austin.
- Barker, Fred, 1958, *Precambrian and Tertiary geology of the Las Tablas quadrangle, New Mexico*: New Mexico Bur. Mines and Mineral Res., Bull. 45.
- Dane, C. H., 1948, *Geology and oil possibilities of the eastern San Juan basin, Rio Arriba County, New Mexico*; U. S. Geol. Survey Oil and Gas Invest. Prelim. Map 78.
- , 1960, the boundary between rocks of Carlile and Niobrara age in San Juan Basin, New Mexico and Colorado: *Amer. Jour. Sci., Bradley Volume*, V. 258-A, p. 45-56.
- Davis, J. H., 1960, *Geology of El Vado area, Rio Arriba County, New Mexico*: unpub. M. A. thesis, The Univ. of Texas, Austin.
- Doney, H. H., 1961, *Geology of Cebolla quadrangle, New Mexico*: Ph.D. dissertation in preparation, The Univ. of Texas, Austin.
- Kelley, V. C., 1950, *Regional structure of the San Juan Basin*: p. 101-108 in *New Mexico Geol. Soc. Guidebook of the San Juan Basin, New Mexico and Colorado*.
- Longgood, T. E., Jr., 1960, *Geology of Chromo Peak area, Rio Arriba County, New Mexico*: unpub. M. A. thesis, The Univ. of Texas, Austin.
- St. John, B. E., 1960, *Geology of the Tecolote Point area, Rio Arriba County, New Mexico*: unpub. M. A. thesis, The Univ. of Texas, Austin.
- Trice, E. L. Jr., 1957, *Geology of Lagunitas Lakes area, Rio Arriba County, New Mexico*: unpub. M. A. thesis, The Univ. of Texas, Austin.
- Wood, G. H., Kelley, V. C., and MacAlpin, A. J., 1948, *Geology of southern part of Archuleta County, New Mexico*: U. S. Geol. Survey Oil and Gas Prelim. Map. 81.

