

New Mexico Geological Society

Downloaded from: <https://nmgs.nmt.edu/publications/guidebooks/18>



Geomorphology and structure in the Grants mineral belt

Robert A. Laverty

1967, pp. 188-194. <https://doi.org/10.56577/FFC-18.188>

in:

Defiance, Zuni, Mt. Taylor Region (Arizona and New Mexico), Trauger, F. D.; [ed.], New Mexico Geological Society 18th Annual Fall Field Conference Guidebook, 228 p. <https://doi.org/10.56577/FFC-18>

This is one of many related papers that were included in the 1967 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.

GEOMORPHOLOGY AND STRUCTURE IN THE GRANTS MINERAL BELT

By

ROBERT A. LAVERTY

U.S. Atomic Energy Commission, Grand Junction, Colorado

INTRODUCTION

The photography of relief models to portray geomorphology and structure was suggested by the work of Keefer (1965). As applied here, molded plastic relief models of the Gallup and Albuquerque 2° sheets, scale 1:250,000, were stapled to a celotex panel and photographed under low angle lighting from the eight principal points of the compass. In each case the vertical line joining the two sheets serves as a reference line for true north.

The Gallup sheet is mounted on the left (west) side of the panel, and the Albuquerque sheet is mounted on the right (east) (Fig. 1a). The northwest-trending Zuni uplift can be seen in the southeast quadrant of the Gallup sheet, its eastern edge being cut by the center reference line. The northeasterly trending basalt-covered plateau of Mesa Chivato, with the Cebolleta Mountains and the crater of Mount Taylor at its southwestern end, can be seen in the southwest quadrant of the Albuquerque quadrangle where it truncates the eastern end of the Zuni uplift.

In the northeast quadrant of the Albuquerque sheet, the Nacimiento uplift is dominated by the Jemez caldera (fig. 1b) bounded on the west by the north-trending scarp of the Nacimiento thrust (fig. 2a), and cut on the southeast by the Rio Grande trench. The corresponding Defiance uplift occupies the north central part of the Gallup sheet (fig. 1b). Between these two latter uplifts is the southern part of the San Juan Basin. The Church-rock, Black Jack, Ambrosia Lake and Laguna ore localities, from northwest to southeast, are indicated by the four "X's" in Figure 1a.

The geomorphic expression of the major structures noted above can be identified in all eight photographs, but the lighting from different directions, enhanced by the vertical exaggeration of the relief model, emphasizes different aspects of each structure. Consideration of these different aspects provides few answers but does make it possible to rephrase the questions.

FRACTURE PATTERNS

The fracture patterns enhanced by the relief model method are those which have topographic expression gross enough to be visible at the scale of the model. Many of the fracture sets measured by Kelley and Clinton (1958) on aerial photographs of scale 1:62,500 are too small to show plainly on the scale of 1:250,000. Amount of displacement on a fault is not necessarily equivalent to the amount of topographic expression. Many joint patterns show clearly

in the photographs because of the amount of weathering along them. On the other hand, such major faults as the San Rafael, San Mateo, Ambrosia, and Bluewater would scarcely be noticed in the photographs unless their existence were previously known. This is unfortunate because these faults appear to have some controlling effect on the limits of uranium-bearing areas.

This study originally was undertaken in the hope of delineating surface features related to uranium deposits, but all that can be said in this regard is that the uranium-bearing areas have the most confused fracture patterns.

NORTHERLY PATTERNS

The most prominent northerly lineaments are those at the east (Nacimiento thrust) and west (rift (?) valley), sides of the San Juan Basin (fig. 2a). It is possible that these lines of weakness are very ancient and that the Nacimiento thrust is more prominent than its southern extension along the Ceja del Rio Puerco because of unequal Laramide rejuvenation. The northerly valley (partly along Black Creek) along the Defiance uplift may be a rift zone as many small northwest-trending folds have been mapped near it (Kelley and Clinton, 1958).

Many smaller northerly fractures are seen in Figure 3a between the rift and the Zuni uplift. A few northerly fractures show up along the northern part of the Zuni uplift. Of these the Bluewater fault is the most prominent, and it can be seen best in Figure 2a about .5 centimeter left of the center reference line. Redistributed uranium ore bodies are commonly found along northerly trending fractures which are so minor that they have little or no surface expression.

A few north-south lines can be seen in the Mt. Taylor volcanics, especially in the drainage from the crater itself. Comparison of Figures 1 and 2 will show the crater drainage starting due east and then breaking sharply south. Figure 4a gives the best emphasis to northerly fractures, including some south of the Jemez caldera.

EASTERLY PATTERNS

One small easterly line in Mt. Taylor crater has been noted above. In Figure 4b, an area of east to east-southeast fractures can be seen just east of Mesa Chivato. This area contains the uranium deposits of the Laguna locality. Northerly and northwesterly fractures are also common in this area.

East to east-southeast fractures are most prominent in the northwestern part of the Zuni uplift where they control the prominent Jurassic and Cretaceous cliffs. These easterly segments, where combined with northerly and

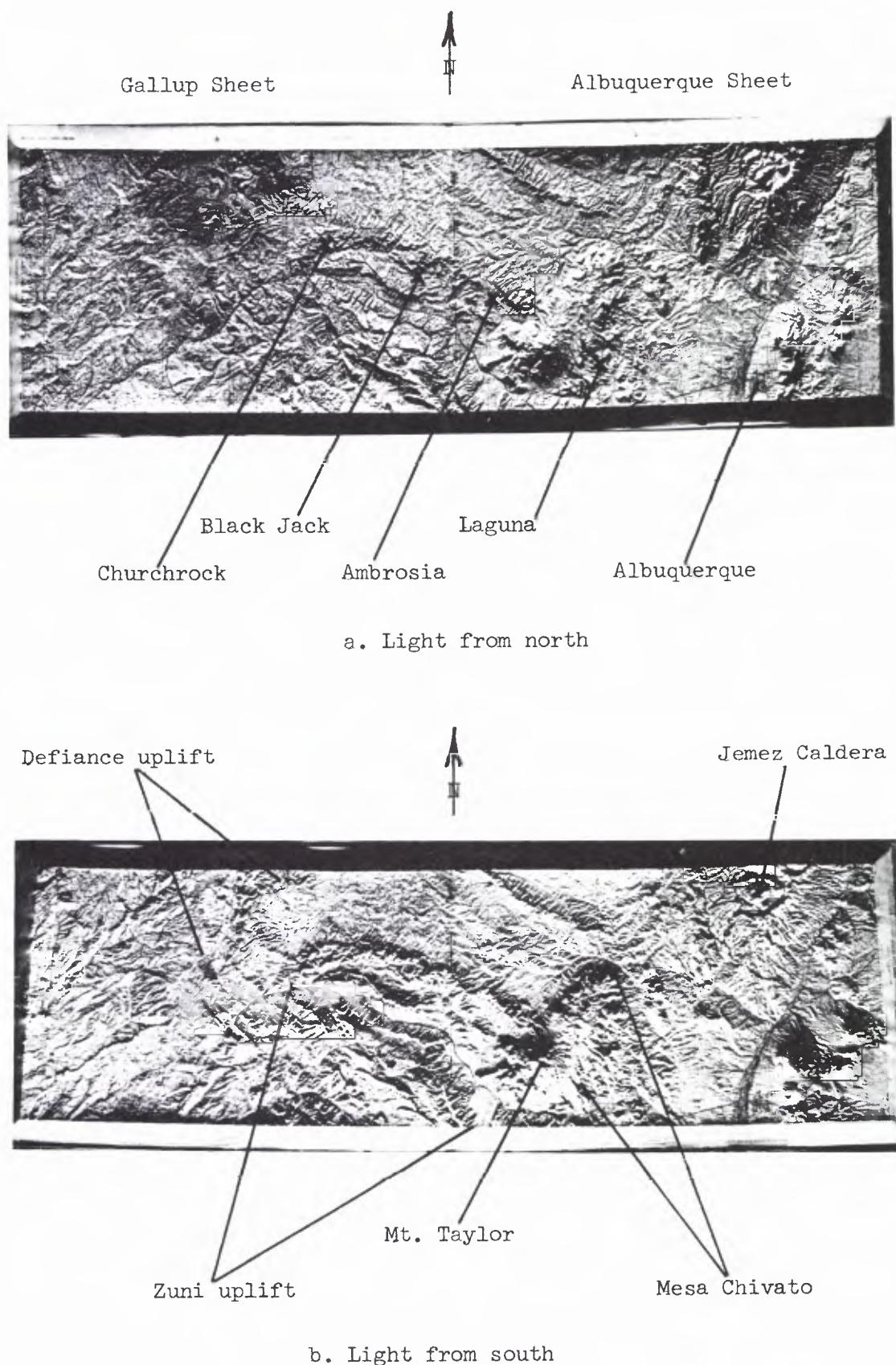


FIGURE 1

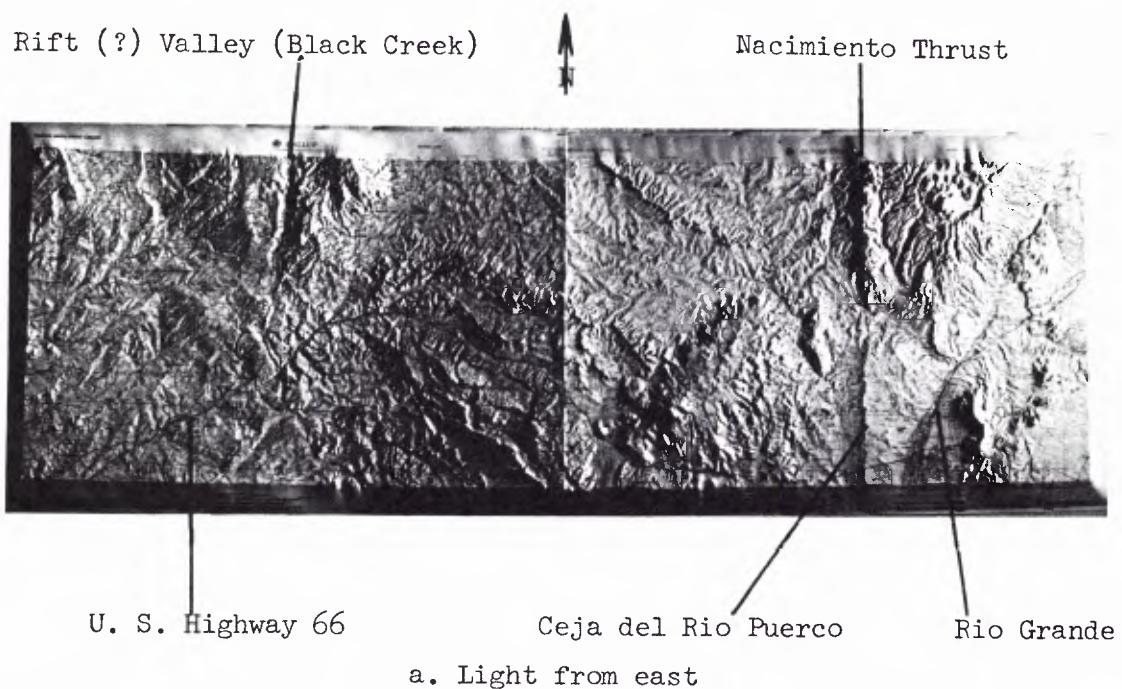
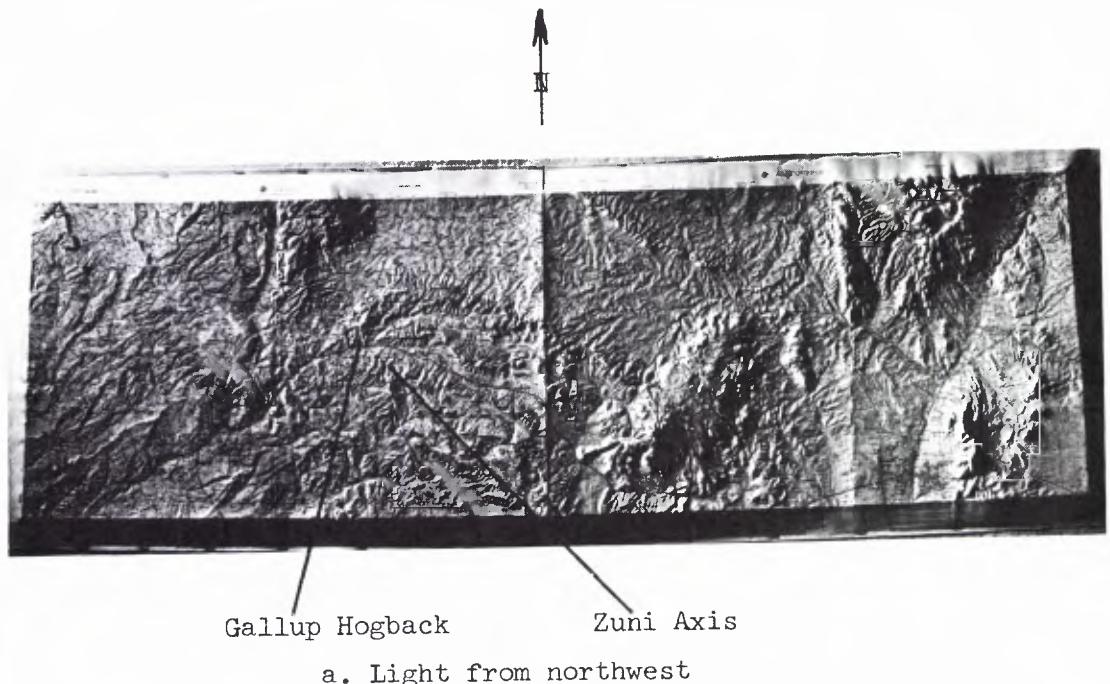
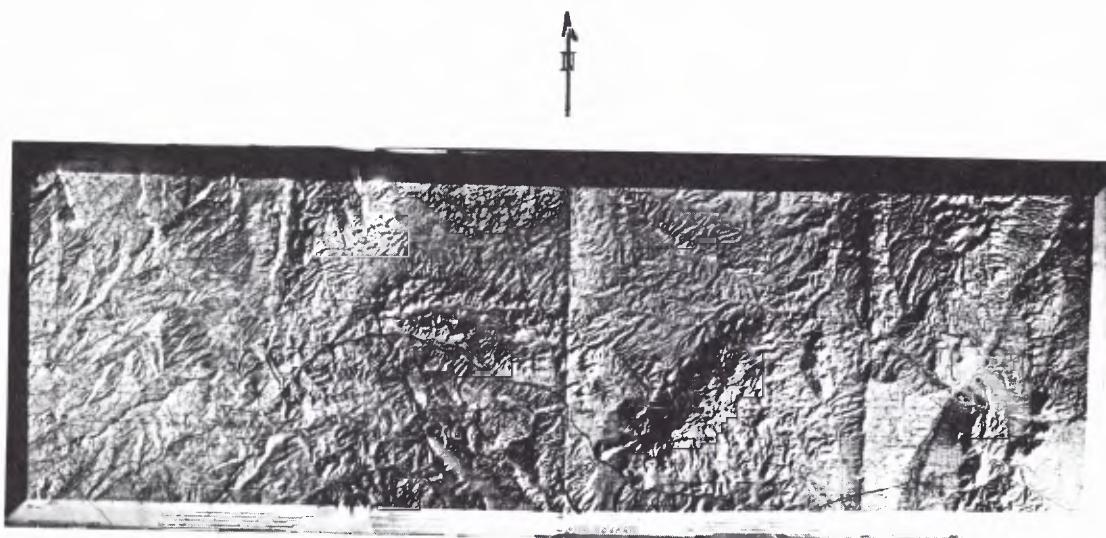


FIGURE 2

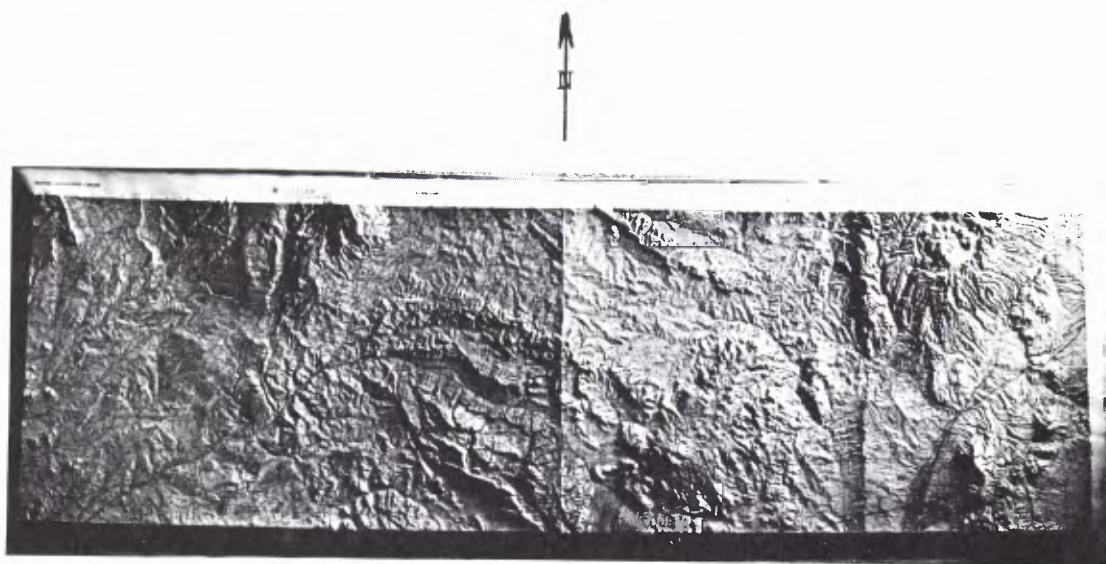


b. Light from southwest

FIGURE 3



a. Light from southeast



b. Light from northeast

northwesterly fracturing, contain large uranium deposits. Many ore bodies and the sedimentary features containing them trend from east to east-southeast. The host rock sedimentation may have been controlled by contemporaneous easterly trending fracturing as well as by the northwesterly fractures described by Clary, et al., (1963).

NORTHEASTERLY PATTERNS

The most prominent of these is the north-northeast alignment of the basalts capping Mesa Chivato. This alignment is paralleled by many fractures in the northern part of the Zuni uplift. Solutions following these north-east fractures have leached ore in some parts of the Grants district and deposited ore in other parts. The north-northeast trending Puerco fault zone east of the uranium deposits at Laguna does not show on any of the photographs; the displacements are apparently too small to show on the scale of 1:250,000, although they show clearly in aerial photographs. The Rio Grande trench trends north-northeast north of Albuquerque.

NORTHWESTERLY PATTERNS

Fracture patterns more or less parallel to the axis of the Zuni uplift are found ubiquitously in all ages of rocks in the area between the two northerly lineaments at the sides of the San Juan Basin. In the Zuni uplift these fractures provide strong topographic features of large extent, while in other parts of the map the topographic expression is of much smaller scale.

TERTIARY VULCANISM

The Mount Taylor and Jemez volcanic fields are probably Miocene to Pliocene (Hunt, 1956; Basset, et al., 1963, Ross, et al., 1961). Figure 3b shows the flatness of the Mt. Taylor volcanics on Mesa Chivato as compared to the northeast-dipping sediments on the flank of the Zuni uplift. It appears that the basalt flowed along a north-northeast trending valley cut in sedimentary rocks that were already tilted. Subsequent erosion has since lowered the surface of these tilted rocks below the base of the basalt. Figure 3b shows with special clarity the northeasterly fracture system, almost exactly parallel to the elongation of the Mount Taylor volcanics, that cuts the Jemez caldera and the southwest flank of its cone. The Rio Grande flows nearly south-southwest at this place.

MAJOR FRACTURES AFFECTING THE SOUTHERN SAN JUAN BASIN

The Nacimiento thrust forms one of the few segments of the basin boundary (Kelley and Clinton, 1958) that is truly precise. This structure is not well displayed in Figures 1a, 1b which are lighted from north and south. In all of the other figures, the Nacimiento thrust not only stands out boldly, but the ridge known locally as the Ceja del Rio Puerco appears to be the southern extension of the bolder structure. This ridge extends south of what is normally considered the southeastern border of the San Juan Basin. Structures closer to the present basin border are probably younger than the north-south lineament. For example, the

Mount Taylor syncline underlies the volcanics of Mesa Chivato. The volcanics are clearly later, and the syncline may be later, than the formation of the basin.

By reference to the southern part of the Defiance monocline (Kelley and Clinton, 1958), and by analogy to the north-trending Nacimiento thrust, the north-trending rift (?) valley (Black Creek) in the Defiance uplift could perhaps be considered part of the structural framework of the San Juan Basin. The actual dip of the strata into the basin occurs east of this lineament and was produced by Laramide forces (Kelley and Clinton, 1958).

The southern closure of the San Juan Basin was due to the rise of the Zuni uplift. It is therefore pertinent to examine the Zuni uplift for evidence of planes of weakness comparable to the north-south planes of weakness east and west of the basin. Such a line of weakness is labeled and marked by a black line in Figure 3a, but it can be seen more clearly in Figures 1b and 3b, striking almost N 45 W at the projected apex of the Zuni uplift along this line. Its straightness contrasts with the curving lines of faulting mapped by field parties in the same area. The line passes through the edges of Precambrian and Paleozoic outcrops, but no northwestward extension is apparent in Triassic or younger rocks. However, parallel lines are seen in the Cretaceous cliffs above Ambrosia Lake, in the expression of the Coolidge monocline between Churchrock and Black Jack, in the southwest face of Horace Mesa and in other more minor places. Subparallel lines are apparent in cuesta faces in Mesozoic sandstones of the Zuni uplift and in some of the ravines in the Tertiary basalts of Mesa Chivato. It might be inferred that the southern rim of the San Juan Basin was formed by rejuvenation of ancient northwesterly faults, regardless of whether vertical or horizontal forces were involved.

All three of these major lines of weakness, the Nacimiento thrust, the Defiance monocline, and the Zuni northwest axis, are probably of Laramide age for a major part of their dislocations, but parallel post-Laramide fractures are seen, and pre-Laramide movements are surely possible. It is then inferred that the basic framework of the San Juan Basin is a net of ancient north and northwest striking faults, dislocated by Laramide pressures, and modified by Tertiary vulcanism.

SUMMARY

In the same way that morning and afternoon flights emphasize different features in aerial photographs, low angle lighting of relief models can be used to provide photographs emphasizing particular geomorphic features. The geomorphology, in turn, provides insight into the structural problems of the area. Although this method may decrease the total amount of field work by directing attention to critical areas, it is not proposed as a substitute for either mapping or photogeology. In the Grants district the results suggest that the major fracture patterns had a long history. Such a long time of activity leads to the possibility that fracturing had considerable effect on the conditions of deposition of uranium host rocks as well as affecting passage of epigenetic solutions through them.

REFERENCES

- Bassett, W. A., Kerr, P. F., Schaeffer, O. A., and Stoenner, R. W., 1963, Potassium-Argon Ages of Volcanic Rocks North of Grants, in Geology and Technology of the Grants Uranium Region, New Mexico Bureau of Mines and Mineral Resources, Memoir 15, p. 214-216.
- Clary, T. A., Mobley, C. M., and Moulton, G. F., Jr., 1963, Geological Setting of an Anomalous Ore Deposit in the Section 30 Mine, Ambrosia Lake Area, in Geology and Technology of the Grants Uranium Region, New Mexico Bureau of Mines and Mineral Resources, Memoir 15, p. 72-79.
- Hunt, Charles B., 1956, Cenozoic Geology of the Colorado Plateau: U. S. Geol. Survey Prof. Paper 279.
- Keefer, William R., 1965, Stratigraphy and Geologic History of the Uppermost Cretaceous, Paleocene, and Lower Eocene Rocks in the Wind River Basin, Wyoming, U.S. Geol. Survey Prof. Paper 495-A.
- Kelley, Vincent C., 1955, Regional Tectonics of the Colorado Plateau and Relationship to the Origin and Distribution of Uranium, in University of New Mexico Publications in Geology, Number 5, The University of New Mexico Press.
- _____, and Clinton, N. James, 1958, Fracture Systems and Tectonic Elements of the Colorado Plateau: U. S. Atomic Energy Comm. RME-108, Tech. Inf. Service, Oak Ridge, Tenn.
- Ross, C. S., Smith, R. L., and Bailey, R. A., 1961, Outline of the Geology of the Jemez Mountains, New Mexico, in Guidebook of the Albuquerque Country, New Mexico Geol. Soc. Twelfth Field Conference, p. 139-143.