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THE "ALPINE BASIN AND RANGE PROVINCE" OF NORTH-CENTRAL CHIHUAHUA

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ABSTRACT

North-central Chihuahua lies within the Basin and Range Province of North America, a physiographic or tectonic entity that resulted from block-faulting.

The overwhelming majority of the mapped structures in north-central Chihuahua are folds, and map evidence is more than scarce to prove the presence of faulted blocks. No hypothetical but tangible data are needed to place the region into this province whose name genetically denotes geologic processes.

The adequate breakdown of the Cenozoic sequence is considered to be the proper tool to work out the post-folding structure of the region, whose understanding is the prerequisite for intelligent groundwater, mining and oil exploration.

RESUMEN

La parte centro-septentrional de Chihuahua se encuentra en la Provincia de Sierras y Cuencas de Norte America, una unidad fisiográfica o tectónica, que debe su origen a fallamiento en bloques.

La inmcnsa mayoria de las estructuras cartografiadas en la parte centro-septentrional de Chihuahua son pliegues y los mapas existentes, mediante sus datos, no apoyan la presencia de bloques de fallamiento. Sc necesitan datos no hipotéticos sino veridicos para colocar esta region en la provincia cuyo nombre indica procesos genéticos de su desarrollo.

La subdivision adecuada de la secuencia cenozoica se considera como el paso mas indicado para descifrar la estructura post-plegamiento, cuyo entendimiento, a su vez, se considera como un prerequisito indispensable para llevar a cabo un programa inteligente de exploración en busca de aguas subterráneas, yacimientos minerales sepultados, o bien de hidrocarburos.

INTRODUCTION

Existing physiographic divisions of northern Mexico, such as that of Ordónez (1946) or of Raisz (1959), show north-central Chihuahua as part of the Basin and Range Province of North America. It is worth while to pause a little on this subject, especially at the onset of a field trip to this part of the continent.

The term "Basin and Range" in a structural sense was coined by Bailey Willis more than 30 years ago. The same term was employed in a geomorphic sense by Cotton exactly 30 years ago (Howell, 1960, p. 26) . In both contexts, the originating and dominating tectonic process is stated to be the faulting. An excellent account on the structure of the Basin and Range Province in Utah, Nevada and California together with a historical analysis was given by Nolan (1943) many years ago.

In north-central Chihuahua the abundance of block-faults is not readily recognizable due to the fact that the mountain ranges are complex fold structures with a NNW-SSE regional trend, formed chiefly in Lower Cretaceous limestones. Cursory examination of the terrain suggests that the mountain ranges are either major, locally thrusted, anticlines or anticlinoria, whereas the intermontaine basins are synclinoria, filled with late Tertiary elastics. This conclusion, however, cannot stand the "acid test," unless it can be proved that the mountain ranges are at the same time anticlines and the basins synclines, all produced by basement folding *(plis de* fond). This interpretation, of course, would not be new, inasmuch as the great pioneer American geologist, Clarence King (1870) set forth such an interpretation 100 years ago.

ONE PERIOD OF FOLDING

No matter how much plastic deformation (resulting in folding) is brought in to account for the structural make-up of north-central Chihuahua, under strict observance of the principles of mechanics and rocks deformation, the present structures cannot be explained to be the result of one period of folding.

The mountain ranges, as was stated above, are made up of intensely folded Lower Cretaceous limestones, and, with the exception of the Samalayuca, Placer de Guadalupe-Plomosas, and the Palomas areas, pre-Cretaceous rocks do not come up to the surface. One would expect such older rocks to be exposed in the case of basement anticlines, if in fact basement folding produced the mountain ranges of the entire region. On the other hand, the geometry of the folds, both individually and in each mountain range as a whole, indicates that these are parallel folds, and hence,

they diminish and vanish at a very shallow depth, on a surface of décollement or, if it is preferred, of a tectonic unconformity. This feature has been recognized by the writer in similar rocks and structures that are present farther south, between Torreón and Monterrey (de Cserna, 1956) . Thus, the folds and associated small thrusts, are the result of a very shallow deformation, which could have been caused by gravity sliding that was active from the west toward the cast. The folded structures resemble those that make up parts of the Appalachians, in the eastern United States and of the Jura Mountains in the border region between France and Switzerland. On the assumption that this mechanism produced the folds that are seen in the mountain ranges in north-central Chihuahua, it is totally incomprehensible how a thin sheet of sedimentary cover, probably quite wet in part, yet at the time of the folding could have become wrinkled up over a surface (1. e. the surface of the tectonic unconformity) that had a relief of about 4,000 m. Thus, one period of folding, just does not work!

TWO PERIODS OF FOLDING

After discarding the concept of a single period of deformation, the logical step, observing methodology in science, is to consider two periods, which would imply that the already tightly folded strata experienced a second period of folding.

In areas of intense plastic deformation, such as in the Appalachians or in the Alps, recent studies demonstrated the folded nature of the thrust-planes. Such structures, to date have not been recognized in northern Mexico, which, of course cannot be cited as a fully proved negative evidence. Farther south, in the Torreón-Monterrey region, the tight folds, that strike E-W, appear to be modified by basement folding which process followed the formation of the tight folds (de Cserna, 1956, p. 78). In that region, due to the oblique to perpendicular trend of the tight folds with respect to the NNW-SSE strike of the basement folds, (which were considered to be shallow folds or plis de couverture), such modifications were not too difficult to recognize. In north-central Chihuahua, however, such features are not readily visible. Local westward overturning has more significance as to the nature of the underlying lithology (i. e., the presence of evaporites), than as to the regional tectonics. At any rate, the magnitude of basement folding, or the structural relief produced by that folding, is far too much less than the structural relief that can be observed in the area today. Very careful structural work is needed to ascertain the nature of a postulated second period of folding.

BLOCK FAULTING AFTER TWO PERIODS OF FOLDING

To recognize and prove deformation in geology, one needs reference horizons. Upon observing the Mesozoic rocks in north-central Chihuahua, one can see that they are deformed by folding and thus this deformation took place in post-Mesozoic time.

Geological mapping to date in the area generally has succeeded in separating the post-Mesozoic rocks as older and younger volcanics, and as basin-fill and alluvium. Of these four gross Cenozoic units, only the older volcanics have shed significant information on the Cenozoic tectonic history of the region. Where these older volcanics are present (generally of acid to intermediate in composition), their juxtaposition to the Mesozoic rocks or their tilted nature suggests evidence of local faulting. Elsewhere, the Cenozoic basin-fill, which has not been adequately subdivided, has not provided to date conclusive evidence as to the presence of major faults, and hence to the block-faulted nature of the entire region. On the other hand, the presence of flat-lying, apparently not tilted, volcanics does not necessarily prove the absence of faults, as has been proved in southeastern Arizona by Sabins in 1957.

CONCLUSIONS

Considering the present state of affairs in north-central Chihuahua within the Basin and Range Province of North America, the overwhelming majority of proved geologic structures are folds mainly of the Alpine type. The term "Basin and Range" truly describes the gross physiographic aspect of the region; however, map evidence still is lacking to support genetic consideration of the physiography. Adequate breakdown of the Cenozoic sequence is considered to be the tool by which the post-folding structure of the entire region may be worked out. The proper understanding of the structure of the entire region is essential to intelligent subsurface exploration for groundwater, metallic mineral and hydrocarbon accumulations.

REFERENCES CITED

Cserna, Zoltan de, 1956, Tectónica de la Sierra Madre Oriental de Mexico, entre Torreon y Monterrey: Congr. Geol. Internal., 20th, Mexico, Monogr., 87 p.

Howell, J. V., Coord, Chairman, 1960, Glossary of geology and related sciences: Am. Geol. Institute, Washington, D. C., 325 p.

King, Clarence, 1870, U.S. Geol. Expl. 40th Par., Rept., v. 3, p. 451-473.

Nolan, T. B., 1943, The Basin and Range Province in Utah, Nevada and California: U.S. Geol. Survey, Prof. Paper 197-D, p. 141-196.

Ordófiez, Ezequiel, 1946, Las principales provincial geográficas y geológicas de la RepUblica Mexicana: en Guia del explorador minero; Com. Direct. Invest. Rec. Minerales, Mexico, D. F., p. 103-142.

Raisz, Erwin, 1959, Landforms of Mexico: Cambridge, Mass., map with text, approx. scale 1:3,000,000.

Sabins, F. F., 1957, Geology of the Cochise Head and western part of the Vanar Quadrangles, Arizona: Bull. Geol. Soc. America, v. 68, p. 1315-132171