Charleston, Santiago

LOWER CRETACEOUS STRATIGRAPHY AND STRUCTURE, NORTHERN MEXICO

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A SUMMARY OF THE STRUCTURAL GEOLOGY AND TECTONICS OF THE STATE OF COAHUILA, MEXICO

Santiago Charleston

CONCIT, S.C.
Dragon n14, Col. Prado - Churubusco
Mexico 13, D.F.

INTRODUCTION

The spectacular geologic structures in the State of Coahuila (Figs. 1-3 and Plate A, in pocket) have provided a fascinating structural and stratigraphic laboratory for geologic studies during this century which have had broad implications in understanding the regional stratigraphy and tectonics of northern Mexico. Pioneer studies in Coahuila were conducted by Burckhardt (1906, 1930), Baker (1934, 1941, a, b), Böse (1923) and Cavins (1927). Subsequently, investigations by the faculty of the University of Michigan, led by L.B. Kellum, completed basic reconnaissance and laid the foundation upon which all later workers have built. Some of their more significant contributions were by Kellum (1936), Kellum et. al. (1936), Imlay (1936, 1937, 1938 and 1943) and Kelly (1936). During the fifties, and after celebration of the International Geological Congress in Mexico City, several remarkable papers integrated all previous work with extensive additional investigations in Coahuila and adjacent states to provide (for the first time) a regional overview of the tectonics and stratigraphy of northern Mexico. Two of the most important of these are the outstanding investigations of Humphrey (1956) and De Cserna (1956). Since then, there have been many additional publications on the geology of Coahuila which provided information useful in refining tectonic interpretations; among these are the papers of Alvarez (1958), Murray (1959), Weidie and Murray (1961), Wolleben and Murray (1959), Diaz (1961), Guzman and De Cserna (1963), King (1969), Gonzalez (1976), and Tardy (1973 and 1980). Several of the papers cited above, and a great amount of work not noted here, are unpublished reports in the files of several Mexican institutions which generally do not receive the credit they are due for contributions by their geologists to the geology of this region. Four of these institutions are: Petroleos Mexicanos, Instituto Mexicano del Petroleo, Consejo de Recursos Minerales, and the Instituto de Geologia de la U.N.A.M.

COAHUILA TECTONIC PROVINCES

The tectonic subdivision of northern Mexico currently used by most workers is that of Humphrey (1956), who recognized the intimate relationship between the present day geomorphology of the area and structural and tectonic patterns. He divided the area into nine different tectono-geomorphologic provinces (Humphrey, op.cit. p. 25). Tectonic subdivision used in this paper is based on the work of Humphrey but, in view of more recent data, has been revised as follows:

1. The Sierra Madre Transverse Folded Belt
2. The Parras Basin
3. The Coahuila Platform
4. The Coahuila Folded Belt
5. The Coahuila Texas-Craton
6. The Basin and Range

1. THE SIERRA MADRE TRANSVERSE FOLDED BELT

This tectonic province is a very conspicuous.

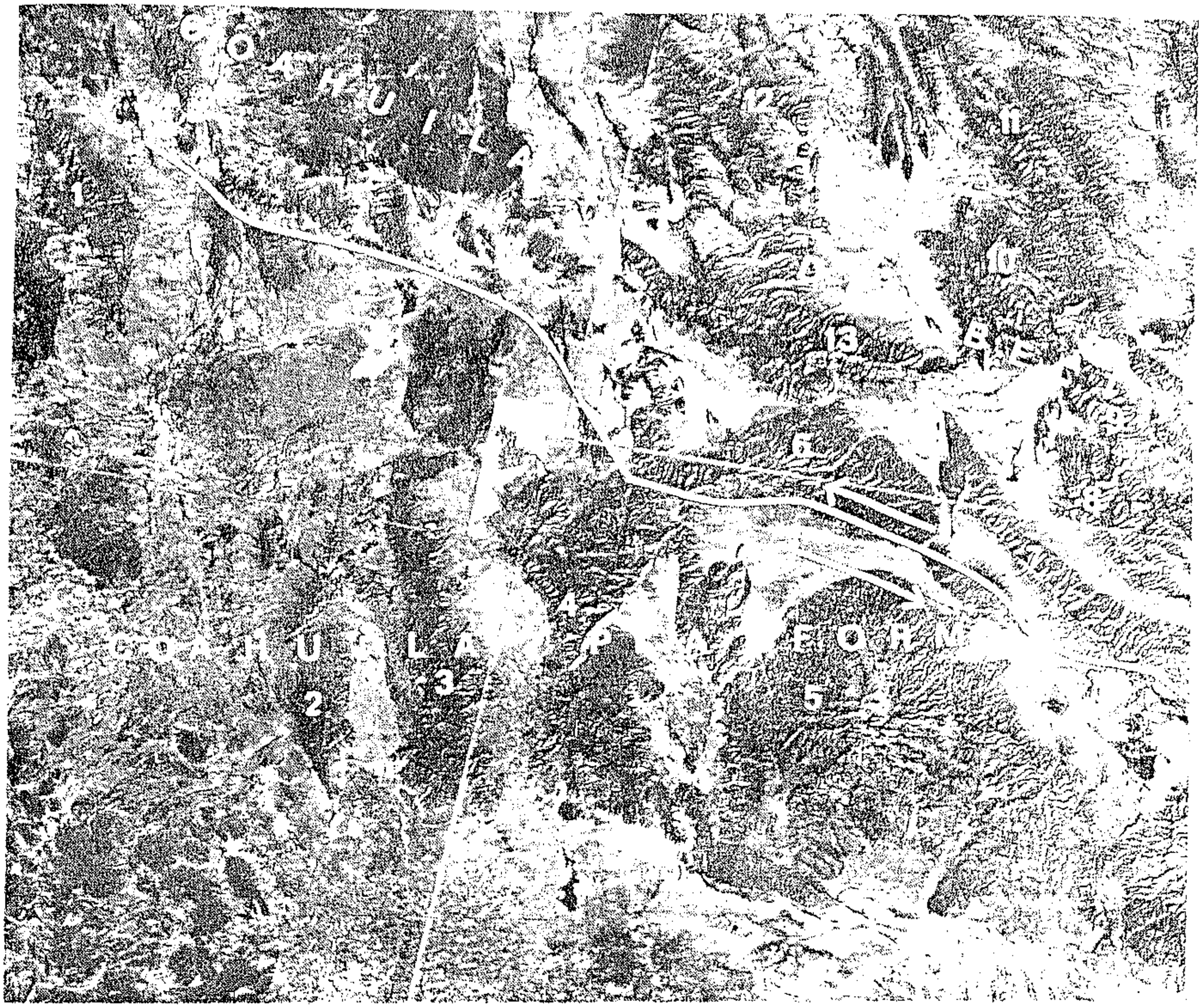

Figure 1. — LANDSAT image of the southwestern portion of the State of Coahuila, showing the position of the San Marcos Fault which separates the Coahuila Folded Belt from the Coahuila Platform. The structures numbered in this image are as follows: 1. El Diablo Anticline, 2. Sierra de la Campana, 3. Sierra de Tlahualilo, 4. Sierra Las Delicias, 5. Sierra de los Alamitos, 6. La Fraqua Anticline, 7. San Marcos Anticline, 8. Barril Viejo Anticline, 9. Aqua Chiquita Anticline, 10. Menchaca Anticline, 11. Padilla Anticline, 12. La Mula Anticline and 13. Sierra de La Madera Anticline.

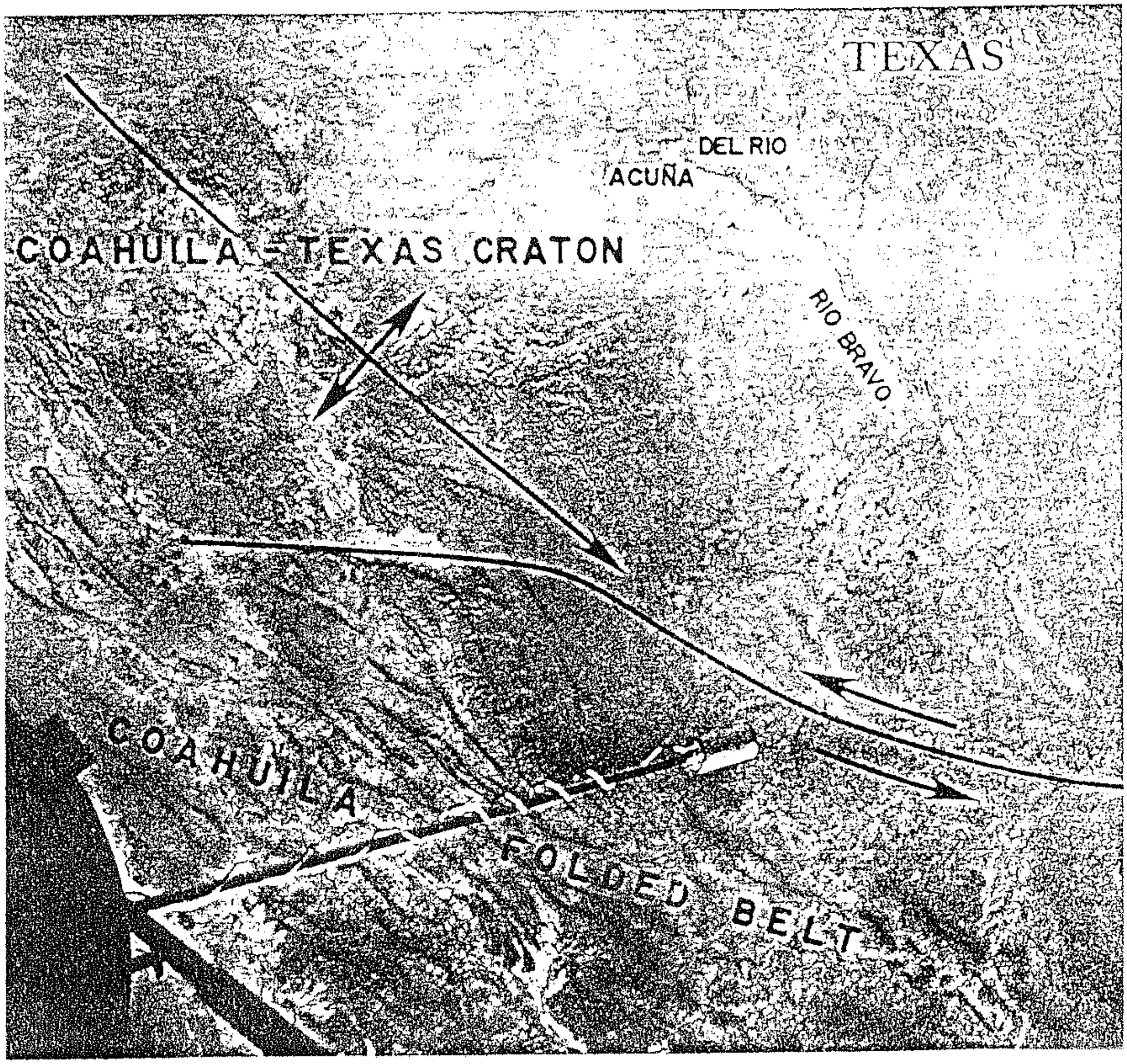

Figure 2 — Gemini XII image of the northern portion of Coahuila, showing the La Babia Fault dividing The Serrania del Burro Anticlinorium of the Coahuila-Texas Craton in the north, from the tightly folded anticlines of the Coahuila Folded Belt in the south.

From La Babia Valley the fault continues toward the southeast (Fig. 2), more or less parallel to the Sabinas-Salado River, which may be a fault controlled drainage system.

The southern left-lateral fault that abruptly separates the Coahuila Folded Belt from the Coahuila Platform, (Fig. 1, 3, and Plate A) is herein named the San Marcos Fault from the Sierra de San Marcos. This fault has been considered by geologists of Pemex (unpublished manuscripts) as an overthrust; however, recent field work and interpretation of LANDSAT images by the author (Fig. 1 and 3) has demonstrated that it is a transcurrent fault. Many folds are practically cut in half by the fault, and the left-lateral direction of offset is clearly evident on the photograph (Fig. 3).

5. THE COAHUILA-TEXAS CRATON

This area is located in the northern most part of the State of Coahuila (Fig. 2, Plate A). As with the Coahuila Platform, the structures of this province consist of broad, gentle, folds generally oriented NW-SE. Among these folds are the Serrania del Burro Anticlinorium, the Agua Verde Anticline, the Treviño-Chupadero Anticline (Salado Arch) and the Peyotes Anticline (Plate A). Humphrey (1956, p. 25) applied the name Sierras Tamaulipecas to this area and included the Sierra de Tamaulipas, The Sierra de San Carlos, the Sierra de Picachos and other mountain ranges that roughly coincide with the Upper Jurassic paleogeographic feature known as the Tamaulipas Peninsula (Smith, 1981, Fig. 1).

The basement rocks of the Coahuila-Texas Craton, within the State of Coahuila, are composed of Upper Paleozoic metamorphic rocks (Flawn and Maxwell, 1958) which are apparently related to the interior portion of the Marathon-Ouachita Geosyncline. Overlying these metamorphic rocks there is a 2000 meter (6500 feet) thick sequence of shallow water, Lower and Upper Cretaceous limestone and shale. These sediments have been studied in detail by Smith (1970).

6. THE BASIN AND RANGE PROVINCE

This province is located in the northwestern corner of the State of Coahuila, immediately south of the Big Bend region of Texas, and is a narrow southeastern extension of the Basin and Range province of western United States and northern Mexico. The most distinctive characteristic of this area is the presence of numerous tertiary normal faults that generally parallel but in some cases cut pre-existing Laramide structures. Most of these faults are oriented NW-SE, with vertical displacement of up to several hundred meters. Examples of these faults are the Sierra del Carmen and Santa Elena faults (Plate A) which bound a broad graben located south of the Big Bend of Texas.

OROGENIC HISTORY

At the end of the Cretaceous and beginning of the Tertiary, the Coahuila area began to experience tectonic deformation related to the Laramide Orogeny. As suggested by Humphrey (1956, p. 25) the degree of deformation in Mesozoic sediments was largely controlled by the position of Upper Jurassic paleogeographic elements. Thus, the areas of greater Cretaceous downwarping such as the Sabinas Gulf and the Mexican Geosynline, were strongly deformed and correspond to the structural welts of the Coahuila Folded Belt and the Sierra Madre Transverse Folded Belt. At the same time the sediments overlying the Upper Jurassic Coahuila and Tamaulipas Peninsulas, which partially correspond to the Coahuila-Texas Craton and the Coahuila Platform structural provinces of this paper, were weakly deformed into a series of broad dome-like structures suggesting that the compressive forces of the Laramide Orogeny were partially absorbed by the basement rocks of these positive elements.

The orientation of the structural axes of most of the structures in the Coahuila area, except those of the Sierra Madre, suggest that the compressive forces acted from southwest to northeast. In the case of the Coahuila Folded Belt, the orientation of structural axes (Plate A), agrees fairly well with this interpretation. Humphrey (1956, p. 29) suggested that the compressive forces responsible for the deformation may have been from opposed movements of the Coahuila and Tamaulipas Peninsula, or were transmitted through the basements rocks of the Coahuila Peninsula. Neither of these mechanisms seems probable but no alternative mechanism has been proposed to date.

It is suggested here that the compressive stress responsible for deformation of the Coahuila Folded Belt was a consequence of northwest-southeast shearing between the Coahuila-Texas Craton and the Coahuila Platform. This mechanism would produce the southwest-northeast compression necessary to account for the Coahuila Folded Belt, and the La Babia and San Marcos left-lateral wrench faults which bound the fold belt on the north and south. The southwest directed folds and thrusts in the west and south portions of the belt also fit this stress pattern and were made easier by the presence of the Lower Cretaceous La Virgen evaporites which provided a decollement surface.

In the case of the Sierra Madre Transverse Folded Belt and the Parras Basin it is evident that the compressive forces responsible for the folds in the

Figure 3 — LANDSAT image covering the area near Monterrey, Nevo Leon, showing the position of the San Marcos Fault, the arcuate anticlines of the Sierra Madre Folded Belt (1), The structures of the Parras Basin (2) and the anticlines of the Las Mitras (3) Grutas de Garcia (4), Potrero Chico (5) and Minas Viejas (6).

thick sequence of Upper Jurassic and Cretaceous sediments, acted from north to south, developing a series of tight anticlines and synclines generally overturned toward the north. These folds are wrapped around the south margin of the Coahuila Platform which acted as a resistant block. The folding was accompanied by northward displaced thrust faults. Tardy (1980, p. 25) considers that these thrust faults are part of a regional "nappe" that sheared previous structures and moved along Jurassic evaporites which acted as a decollement surface.

The last tectonic episode which occurred in the area was the development of the normal faults located in the northwestern corner of the State (Basin and Range Province). These faults cut previous structures and formed a series of independent blocks.

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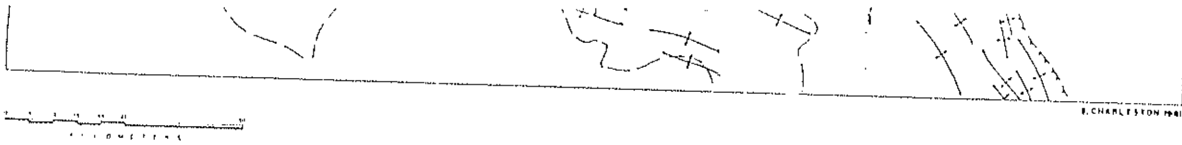

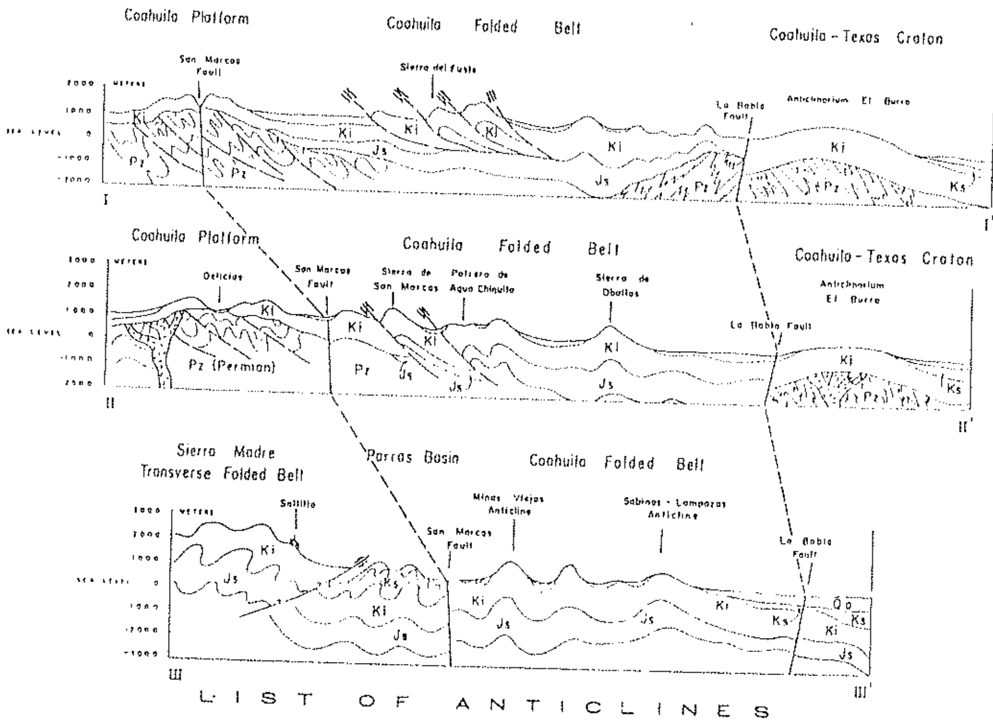

LIST OF ANTICLINES

1. MONTERREY
2. EL PINO
3. SAN VICENTE
4. EL GUAJE
5. ACEBUCHES
6. EL FUSTE
7. EL CABALLO
8. LA MULA
9. PADILLA
10. SIERRA HERMOSA SANTA ROSA
11. SIERRA LA MADERA
12. SIERRA PALO BLANCO
13. LA VIRGEN
14. MENCHACA
15. SACRAMENTO
16. OBALLOS
17. PIEDRAS DE LUMBRE SYNCLINE
18. LA FRAGUA
19. SAN MARCOS
20. BARRIL VIEJO
21. LA GAVIA
22. LA GLORIA
23. LA RATA
24. PAJAROS AZULES
25. GRUTAS DE GARCIA
26. POTRERO CHICO
27. MINAS VIEJAS
28. BUSTAMANTE
29. SABINAS-LAMPAZOS
30. VALLECILLO
31. PICACHOS
32. LA SILLA
33. LAS MITRAS
34. TOPOCHICO
35. TLAHUALILO
36. DELICIAS
37. ALAMITOS
38. LA PAILA
39. PARRAS
40. LOS MUERTOS

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TECTONIC MAP OF THE STATE OF COAHUILA
PLATE A