

TACONIAN (EARLY CALEDONIAN) DEFORMATION IN THE HUASTECA STRUCTURAL BELT OF EASTERN MEXICO*

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ABSTRACT. In eastern Mexico, the gneissic basement of late Precambrian Grenville age is covered by a variety of sedimentary and metamorphic rocks of early Paleozoic age. In northeastern Mexico (Ciudad Victoria and Aramberri), a pre-Middle Silurian chlorite-sericite schist mass is in tectonic contact with the Precambrian. In east-central Mexico (Molango), the Precambrian is covered unconformably by Carboniferous flysch. Farther south in southeastern Mexico (Acatlán), the Precambrian basement is over-ridden by an allochthonous Upper Ordovician metasedimentary and metavolcanic sequence with an adjacent thrust slice and with the nearby presence (at Totoltepec) of a Late Ordovician granitic pluton. Still further southeast (Nochixtlán), the Precambrian basement is overlain discordantly by Tremadocian near-shore sediments, which are covered with an angular unconformity by Osagean (Mississippian) and younger Paleozoic flysch.

These relations are considered to be indicative of an early Paleozoic Deformation which was probably correlative to the Taconian or early Caledonian Deformation of northeastern North America, in the east Mexican Paleozoic Huastecan Structural Belt, and which produced thrust or glide sheets from the east toward the west. These in turn might conceal, in the area of the Gulf Coastal Plain, heretofore undiscovered lower Paleozoic miogeosynclinal sequences with important petroleum potentials.

INTRODUCTION

Fifteen years ago, the author entertained the idea that the pre-Mississippian gneiss and schist that outcrop in the core of a major uplift or anticlinorium of the Sierra Madre Oriental, just west of Ciudad Victoria (fig. 1), resulted from the Taconian Deformation (de Cserna, 1956, p. 55).

Since then, in the Ciudad Victoria area a pre-Mississippian Paleozoic non-metamorphosed sedimentary sequence has been discovered, which permitted the stratigraphic dating of the gneiss and schist as pre-Middle Silurian (Carrillo-Bravo, 1959, 1961; Fries and others, 1962). Shortly after, the gneiss was dated as of late Precambrian Grenville age (Fries and others, 1962, p. 64), and as a result, the author temporarily abandoned this problem. Recently, however, while reviewing the Precambrian geology of Mexico (de Cserna, 1971), his interest in the Taconic problem revived in the light of new data from three localities in southeast Mexico (Totoltepec, Acatlán, and Nochixtlán; fig. 1). The new data suggest that Taconic Deformation certainly was going on in eastern Mexico during the later part of the Ordovician and perhaps during earliest Silurian and that it resulted in the formation of uplifts, the emplacement of plutonic masses, and the development of thrust or glide sheets which today are preserved as klippen.

SUMMARY OF THE RELEVANT DATA

A brief description is given below of the pertinent facts relating to the Taconic Deformation in each area where there is evidence or reasonable suspicion that it is present.

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Fig. 1. Map of Mexico, showing the location of areas to which reference is made in the text, together with those of the suggested Taconian allochthons.

Nochixtlán, Oaxaca.—In the Nochixtlán area, about 70 km to the northwest of the city of Oaxaca (fig. 1), Pantoja discovered in 1965 a Tremadocian sandy shale sequence 200 m thick, which rests with a basal calcarenite on Precambrian (Grenville) gneiss. The Tremadocian sediments, in turn, are overlain with a marked angular unconformity, by upper Paleozoic flysch, whose base is Mississippian (Osagean) (Pantoja-Alor and Robison, 1967; Pantoja-Alor, 1970).

Acatlán, Puebla.—The Acatlán area lies about 180 km southeast of Mexico City and about 60 km northwest of the Nochixtlán area (fig. 1). In 1959, during a field trip to southern Mexico in the company of Professor Eduardo Schmitter of the Instituto de Geología, the writer had the opportunity to examine an excellent outcrop of an augen schist, a short distance northwest of Acatlán. Schmitter collected several samples of the augen schist, and the writer considered the locality as a probable Precambrian one (de Cserna, 1970a, p. 264). On the insistence of the late Dr. Carl Fries, Jr., one of the augen schist samples was turned over to Miss Joan Engels, of Lamont Geological Observatory of Columbia University, who in 1963 reported an age of 448 ± 175 m.y., obtained from microclines of the sample by the Rb-Sr method (Fries and Rincón-Orta, 1965, p. 93). Subsequently, a lead-alpha age of 510 ± 60 m.y. was obtained from a zircon concentrate of a sample of the same rock collected at the same locality (Fries, Schlaepfer, and Rincón-Orta, 1966). No matter what analytical errors are considered, the two dates, for recon-

naissance purposes, indicate a probable Ordovician age for the augen schist.

In pursuing farther the Precambrian metamorphic or magmatic events in south-central Mexico, Fries and the author encountered in late 1963 a foliated granite stock, in the vicinity of Totoltepec, about 20 km east-southeast of Acatlán. A lead-alpha age of 440 ± 50 m.y. was obtained from a zircon concentrate of this granite, corresponding to the Late Ordovician (Fries and others, 1970).

By late 1966, the author had become convinced that there was certainly a major early Paleozoic event in southeast Mexico whose proper recognition by reconnaissance radiometric dating cannot be resolved, unless regional geological mapping is undertaken. Thus, a project was started in which first Ing. Rafael Rodríguez-Torres and later Mario Ruiz-Castellanos, both of Instituto de Geología, participated. In 1970, Dr. Nicholas Rast, visiting professor from the University of Liverpool, England, took charge of the project temporarily, and Fernando Ortega-Gutiérrez, also of Instituto de Geología, joined the project. The first results, published by Rodríguez-Torres (1970) and by Ruiz-Castellanos (1970), cover the region west, southwest, and south of Acatlán. Rodríguez-Torres has shown conclusively that on top of the Precambrian Grenville basement there is a sedimentary-volcanic unit which attained the green schist and lower amphibolite facies and that its contact with the Precambrian is clearly a low-angle overthrust. It was also shown that the augen schist, mentioned above, forms part of this sequence. In turn, these rocks have been partially overridden by another unit, probably of similar age, which consists of sericite schist and quartzite. The next succeeding unit is a weakly metamorphosed flysch with some limestone horizons (de Cserna, 1970b, p. 41), from which Ruiz-Castellanos (1970, p. 60) collected crinoid fragments.

From the above described relations it appears that the lower unit is probably a klippe of a thrust or glide sheet that has overridden, from the east toward the west, the Precambrian basement and, in fact, even a second plate or slice was thrust over it. As these units contain the dated augen schist, it is probably Ordovician. On the other hand, the flysch bearing crinoid fragments is probably upper Paleozoic, correlative with the flysch near Tehuacán (fig. 1; de Cserna, 1970b, p. 41) which is, at least in part, Pennsylvanian (Silva-Pineda, 1970). The folding of the thrusts, and by the same token the klippe and the thrust slice, is probably the result of the latest Paleozoic deformation which also affected the upper Paleozoic flysch.

Ciudad Victoria, Tamaulipas.—The Ciudad Victoria area lies about 250 km south-southeast of the city of Monterrey in northeastern Mexico (fig. 1). The presence of Paleozoic sedimentary rocks on top of the underlying metamorphic basement in the area has been known for almost a half of a century (Girty, 1926). The history of the geologic research in the area has been summarized by Carrillo-Bravo (1961) and by Fries and

others (1962, p. 56-63). The pre-Middle Silurian metamorphic rocks consist of gneiss and chlorite-sericite schist; these are everywhere in fault contact with the Paleozoic sedimentary rocks (Carrillo-Bravo, 1961, p. 6-8).

Fries visited the metamorphic area on three occasions in 1962 and 1965 to examine the contact relations and to collect suitable material for radiometric age determinations. He confirmed that the gneiss-schist contacts are formed by faults, and that one of these contacts provided the avenue for the emplacement of a granitoid rock, whose muscovite concentrate gave a K-Ar age of 310 ± 10 m.y. (Fries and Rincón-Orta, 1965, p. 100-102). The gneiss was dated by several methods, using various samples from different localities, as of late Precambrian Grenville age, whereas one sample from the schist, utilizing a muscovite concentrate, gave a K-Ar age of 315 ± 10 m.y. (Fries and others, 1962, 63-64; Fries and Rincón-Orta, 1965, p. 103). Obviously, this age for the schist is only apparent, because non-metamorphosed Middle Silurian sediments are juxtaposed. The final conclusion of Fries was that both the gneiss and schist were the product of regional metamorphism of one original succession of sediments (Fries and others, 1962, p. 59-60), in spite of the fact that he himself indicated that there was a considerable difference in the strike and dip of foliation in these two units (Fries and Rincón-Orta, 1965, p. 100), and that earlier Flawn (1961, p. 113) pointed out that the geologic relations between these metamorphics had not been clearly established.

The author visited the metamorphic area on several occasions and could not reconcile himself to the idea that both the schist and the gneiss are of the same age and products of the same metamorphism, for the style of deformation in the schist is totally different from that in the gneiss (de Cserna, 1970a, fig. 3 on p. 262). Rather, he is inclined to consider the schist, described as the Granjeno Schist (Carrillo-Bravo, 1961, p. 7), to be a post-Precambrian pre-Middle Silurian unit, probably part of a Taconic klippe, with similar relations to those at Acatlán.

In a recent geological study related to the asbestos deposits in one of the pre-Middle Silurian metamorphic outcrop areas (Novillo Canyon) near Ciudad Victoria, useful information is presented on the internal structure and petrology of the schist and associated serpentinite mass, but the gneiss-schist relations are still unsolved (Salas, 1970).

Aramberri, Nuevo León.—The metamorphic rocks that outcrop in the vicinity of Aramberri form the core of another major anticlinal uplift of the Sierra Madre Oriental. Aramberri lies about 70 km to the northwest of Ciudad Victoria (fig. 1). The presence of metamorphic rocks in this area was first reported by Müllerried (1946, p. 45-49 and fig. 1), who mentioned a total of six outcrop areas between Aramberri and the village of La Escondida, which lies about 8 km to the west. Müllerried's description indicates that the metamorphic terrain consists of gneiss, mica schist, and phyllite, quite similar to the metamorphic terrain at

Ciudad Victoria. Very recently, Mixon, in 1962, mapped the geology of the Aramberri region as part of his doctoral dissertation at Louisiana State University. On his geologic map, however, Mixon shows only schist and no gneiss, and he classified the schist as Precambrian or lower Paleozoic.

The author concludes that the geological conditions of the metamorphic rocks at Aramberri are quite similar to those at Ciudad Victoria, and hence that the gneiss—if present—is Precambrian whereas the schist is Taconic.

GEOTECTONIC SYNTHESIS

The localities above described are all in the east Mexican Paleozoic Huastecan Structural Belt (de Cserna, 1960 and 1961) from which, heretofore, structures resulting from an early Paleozoic Taconic Deformation have not been reported formally. In fact, Taconic structures have been directly recognized heretofore only in northeastern North America, commonly in the form of klippen of thrust or glide sheets (Kay, 1966; Rodgers, 1970). Elsewhere, in the eastern North American early Paleozoic orthogeosynclinal belt, only sedimentological effects, in the form of clastic wedges, of Taconic Deformation have been recognized so far, as in Tennessee (King, 1959, p. 59 and fig. 34) or in the Marathon region of west Texas (King, 1937, p. 43-37 and fig. 16; Young, 1970). Thus, the data from eastern Mexico here presented, extends southward the Taconic belt of deformation, in the form of allochthonous masses that glided or thrust from the east toward the west. Curiously enough, to date such klippen have been properly recognized only in areas where adequate geologic mapping had been carried out, as in the Acatlán region. Mapping of similar quality probably will resolve conclusively whether the schists at Ciudad Victoria and Aramberri are also klippen. However, reliable data from Nochixtlán, described above, and from Molango reported by von Kuegelgen (1958) and by Carrillo-Bravo (*in* Fries and Rincón-Orta, 1965, p. 67-68) in east-central Mexico (fig. 1), give no evidence of the presence of such allochthonous masses. Regrettably, in southern and southeastern Mexico the available geological information is not sufficient even to speculate on this problem at this time; in Guatemala, however, the pre-Carboniferous metamorphic terrain might eventually reveal a geotectonic make up like that of the Huasteca Structural Belt.

It is worthy of note, however, that the Taconic klippe at Acatlán consists of metamorphic rocks, and if those at Ciudad Victoria and Aramberri prove to be Taconic, then they are also metamorphic. In this regard they are radically different from the relatively non-metamorphosed rocks of the Taconic klippen described from northeastern North America. It is important to realize, however, that the thrust or glide sheets, made up of metamorphic rocks, have probably overridden lower Paleozoic miogeosynclinal sequences lying to the east of the present front of

the Sierra Madre Oriental, which in turn may constitute potential targets for petroleum exploration, in a similar fashion as, for example, the Rose Hill district in Virginia (Miller and Fuller, 1954).

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