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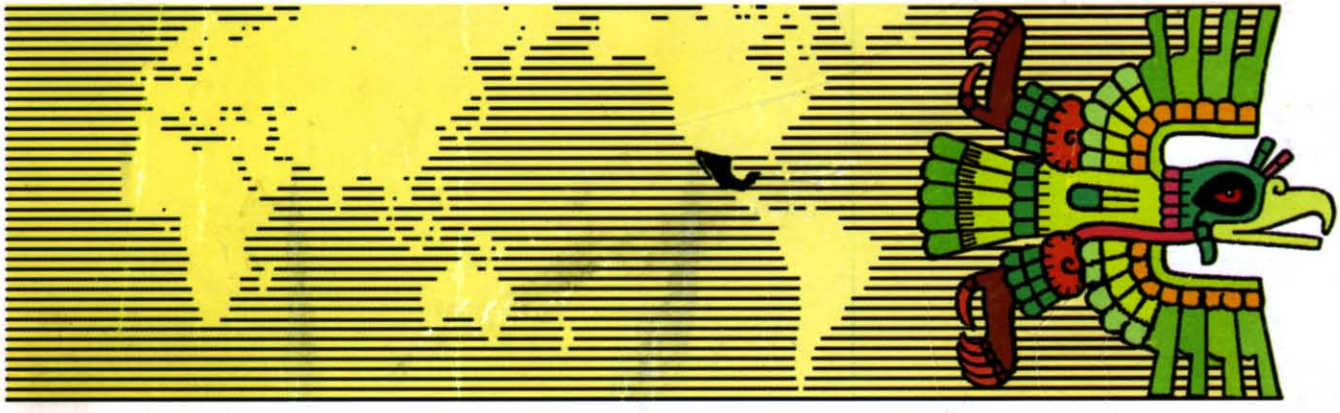
INSTITUTO DE GEOLOGÍA

FIRST CIRCUM-PACIFIC AND CIRCUM-ATLANTIC TERRANE CONFERENCE



TERRANE GEOLOGY OF SOUTHERN MEXICO

GUIDEBOOK OF FIELD TRIP B

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THE PALEOZOIC COVER OF THE MIXTECO TERRANE IN THE OLINALÁ-HUAMUXTITLÁN AREA

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INTRODUCTION

This third part of Excursion B consists of a complete traverse through the Mixteco terrane (Figure 1), whose complete stratigraphic column is shown in Figure 2. However, emphasis of this part of the Excursion will be centered in its Paleozoic section, which is made of two parts: An early-middle Paleozoic metamorphic basement (Acatlan Complex), and its late Paleozoic shallow marine and continental coverture. Triassic rocks are represented only by scarce plutonic units (intrusions and migmatites), whereas the Jurassic system comprises a thick and extensive sequence of continental red beds and marine intervals, with occasional basaltic lavas and granitic intrusives. The rest of the column (Late Jurassic to Cenozoic) is similar to most of the other terranes that compose the tectonstratigraphic mosaic of southern Mexico.

GEOLOGY OF THE OLINALÁ-HUAMUXTITLÁN AREA

The main purpose of this part of Excursion B is to show the nature and stratigraphic relations between the Acatlán Complex and its more ancient supracrustal cover, here represented by the Permian Los Arcos Formation (Corona-Esquivel, 1981). Nevertheless, a brief description of the pre-Mesozoic stratigraphy of the Olinalá area follows below, in order to familiarize the participants with the nature of the stratigraphic record of the Mixteco terrane.

STRATIGRAPHY OF THE ACATLÁN COMPLEX

The Olinalá-Huamuxtitlán region, located in the northeastern part of the State of Guerrero, has one of the most complete geologic records of southern Mexico. This fact allows to study the tectonic evolution of this region from early Paleozoic to the present (Figures 2 and 3).

The oldest rocks forming the basement belong to the Acatlán Complex, originally igneous and sedimentary rocks of Cambrian-Ordovician age that were metamorphosed 380 ± 6 Ma ago (Devonian period). Subsequently, during the Mississippian and Pennsylvanian, the region was emerged and eroded to depths of approximately 20 km.

The basement cover started to form during the Permian with the deposition of Los Arcos Formation under a shallow sea environment. This permitted the deposition of detrital and calcareous sediments and the preservation of an abundant and diversified fauna.

During the Triassic, the Las Lluvias Ignimbrite marks a continental volcanic period related to a tensional zone of the continental crust or to subduction on a far convergent margin.

In the Middle Jurassic shallow-water conditions are repeated, permitting the deposition of the Cualac Conglomerate and Tecocoyunca Group.

Studies of the ammonites from the upper part of the Tecocoyunca Group suggest that during this time a connection between the Pacific and Tethys seas existed. It is inferred that towards the end of this period the La Carbonera, Cualac and Xalmolapa structures were formed by compression and the areas were exposed to erosion.

The Early Cretaceous deposits belong to the Tlalquiltepec Formation, whose lithology indicates an infralittoral to continental environment. Simultaneously, in a region towards the east, gypsum and limestone of the Tlaltepexi Formation were deposited, indicating a marine transgression from the Gulf of Mexico, which, later on, during the middle Cretaceous, culminated in the flooding of the eastern part of the area allowing the deposition of Teposcolula Limestone. Towards the end of Cretaceous and the early Tertiary, the effects of the Hidalgoan orogeny (Laramide) are observable in the existing structures and the folding of the post-Jurassic rocks.

The Balsas Formation was deposited in the Paleocene on restricted surfaces and later during the Eocene-Oligocene a vast surface of the studied area was covered by volcanic and volcaniclastic rocks of the Chiauzingo Formation, which belongs to the volcanic event present in an ample region of southern Mexico. This volcanism is related to a Tertiary continental magmatic arc whose location is not yet defined.

After the volcanic event, normal faulting caused dislocation of blocks and a strike-slip fault displaced and cut several structures, of which the Huamuxtitlán fault is the most important. The present morphology indicates constant uplift during the last 10 or 15 million years.

At Olinalá, as over most of its 10,000 km^2 exposed in southern Mexico, the lowermost structural unit of the Acatlan Complex is the Cosoltepec Formation (Ortega-Gutiérrez, 1978a), a low grade, monotonous sequence of phyllites, quartzite and psammites that includes notorious segments of exotic greenstones that in places have preserved convincing evidence of its former volcanic nature and deep-marine environment of deposition. At Coatlaco, in the Olinalá area, for example, this evidence consists of its micropillowed structure, variolitic texture, and its inclusion within carbonate-free, flysch-like metasediments exhibiting a finely banded structure and containing abundant ribboned metachert and exotic fragments of extremely attenuated clasts of serpentinite.

Not far from Olinalá along the route to Ixcamilpa, the Acatlan Complex includes an interval where the pelagic character of Cosoltepec Formation is clear. There it consists of laminated black and light-gray phyllites, alternating with coherent to badly broken schistose metapsammite and thinnly banded metachert systematically associated with the dark phyllites, probably marking their original sedimentary tops. Blocks of olistolithic (?) massive quartzite float amid the phyllites.

The whole suite is interpreted as part of a trench deposit trapped in a subduction zone that could not follow the plate into the mantle, but remained near the surface as an accretionary wedge into which fragments of buoyant oceanic floor were trimmed and incorporated by the sedimentary mass.

Structurally above and after a short interval of black phyllonite, a complex, high to medium grade (retrogressed) sequence of greenstones, pelitic schists, gneisses, metagranitoids, and banded gneisses crop out, forming part of the formally named Xayacatlan and Esperanza units of the Acatlan Complex (Ortega-Gutiérrez, 1978a).

The most distinctive lithologic attribute of all these rocks is their abundant white mica of obvious tectonic origin, in some cases composing up to 30% of the parent rock. The usual phengitic composition of this mica suggests high pressure for their formation, and the common occurrence of garnet amphibolites and garnetifeous gneisses evokes a similar eclogitic sequence as the one we will directly examine the next day around the Piaxtla area, State of Puebla.

Probably because syntectonic and polyphase deformation caused extreme thinning to rocks of the Acatlan Complex, both the Esperanza or Xayacatlan Formations may be found in direct contact with Cosoltepec Formation. The contact between the two former units is abrupt and usually marked by a few meters of coarse phyllonite, eventhough intrusive relations may be locally discerned, indicating a magmatic origin for the purely granitoid facies of the Esperanza Formation.

The uppermost part of the Acatlan Complex in the Olinalá area, right where the main stop of the day is programed, is

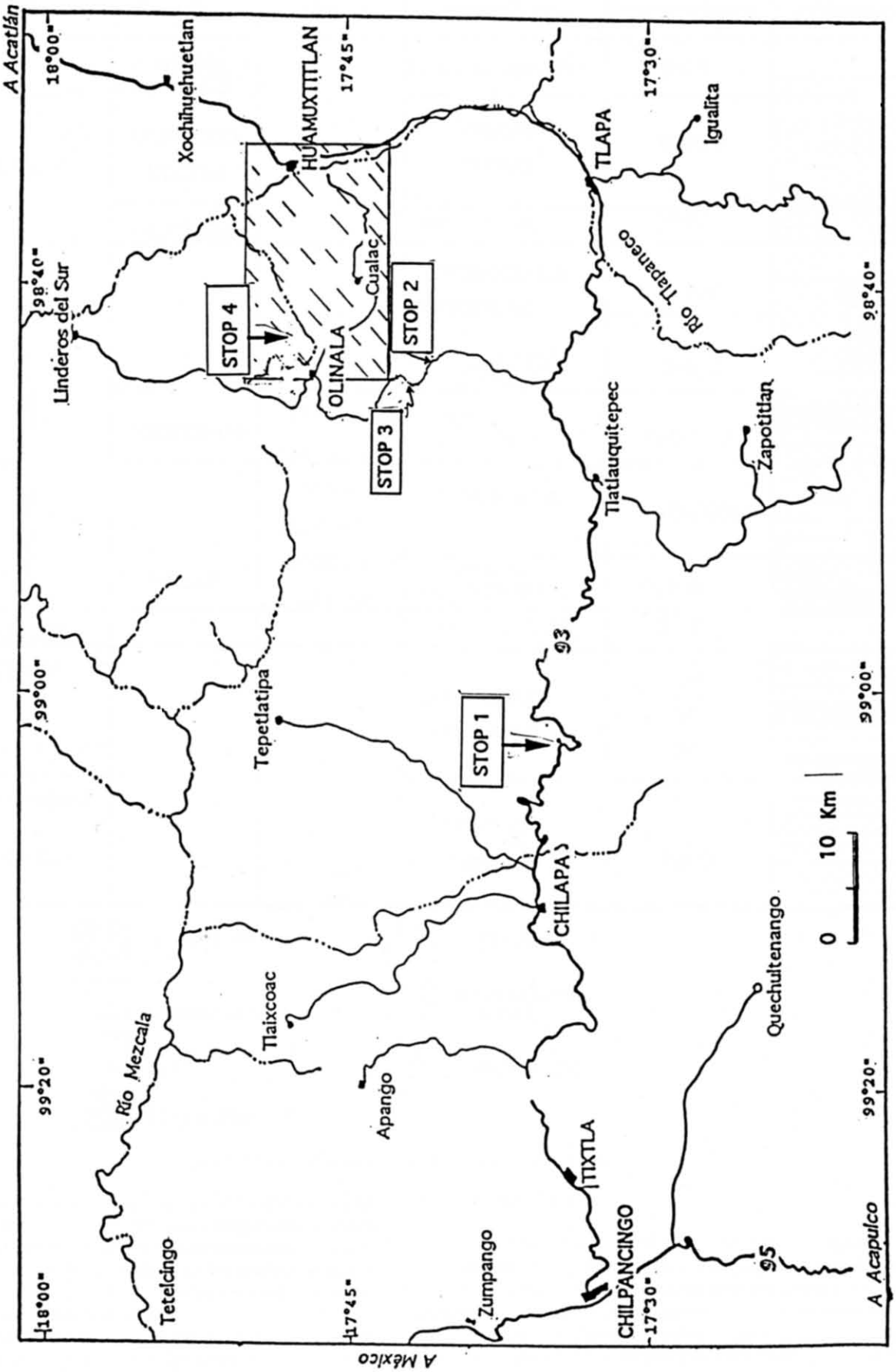


Figure 1. Locality map of the Olinalá-Huamuxtitlán area.

ERA	PERIOD	EPOCH	AGE	FORMATION	THICKNESS	SIMBOLOGY
CENOZOIC	CUATERNARY	PLEISTOCENE AND RECIENT		ALLUVIAL DEPOSITS	0-20	
	TERTIARY	OLIGOCENE EOCENE		VOLCANIC TERTIARY	0-400	
		PALEOCENE		BALSAS FM.	0-80	
MESOZOIC	CRETACEOUS		ALBIAN APTIAN	TEPOSCOLULA LIMESTONE	0-300	
				TLALTEPEXI GYPSUM	0-600	
		NEOCOMIAN	BERRIASIAN BARREMIAN	RED BEDS	100-250	
	JURASSIC	MIDDLE	CALOVIAN BATHONIAN BAJOCIAN AALENIAN	TECOCOYUNCA GROUP	230-2000	
				CUALAC CONGLOMERATE	0-500	
	TRIASSIC			LAS LLUVIAS	50-80	
PALEOZOIC	PERMIAN PENNSYLVANIAN			LOS ARCOS FORMATION	0 a 635	
	DEVONIAN ORDOVICIAN			ACATLAN COMPLEX	> 2000	

LIMESTONE
SANDSOTNE
SHALE
CONGLOMERATE
GYPSUM
METAMORPHYC ROCKS
INGIMBRITE

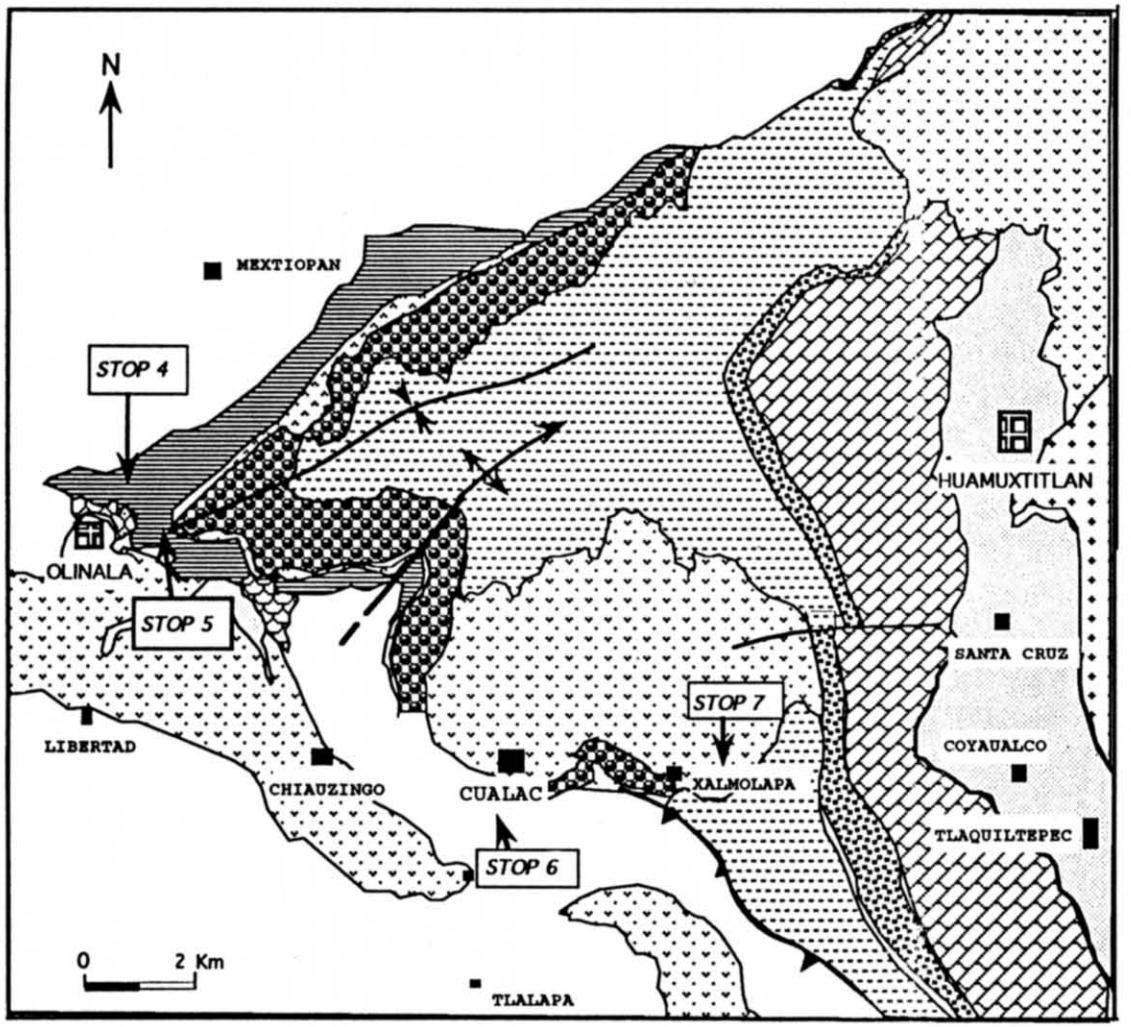
Figure 2. Stratigraphic column the Olinalá-Huamuxtitlán area.

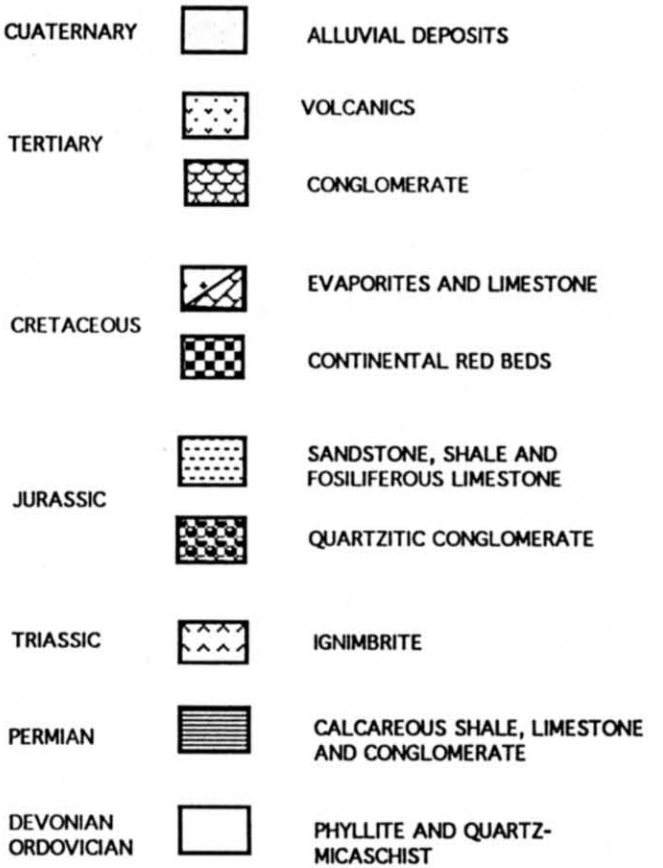
represented by a few hundred meters of slate and metagraywacke below the late Paleozoic unconformity separating basement from cover. Because this unit exhibits only one penetrative deformation and one cleavage, it may be considered in the future a separate formation of the Acatlan Complex, probably correlative with the Tecomate Formation at the type area.

A more comprehensive study of the Acatlán Complex and its significance is given below (Ortega-Gutiérrez, this guidebook).

TECTONIC IMPLICATIONS

The contacts among the Los Arcos, Las Lluvias and Cualac units are structurally parallel, thus implying quiet tectonic conditions across the Permian-Mesozoic time boundary in this part of Mexico. In fact, the apparent continuous deposition of an early Mississippian-Late Permian marine sequence over the Acatlán Complex in the Mixteco terrane indicates anorogenic conditions





After Corona-Esquivel (1985)

Figure 3. Geologic map and structural cross section of the Olinalá-Huamuxtitlán area.

throughout the entire epoch of the Ouachitan orogeny that affected the southern margin of Proterozoic North America. This part of Mexico, therefore, was probably quite distant from any of the colliding continental margins that converged up to the Permian to form west equatorial Pangea.

Although so far undated, the Las Lluvias Ignimbrite presumably formed part of a latest Paleozoic-Early Jurassic magmatic belt that has been more related to the Farallón Plate-American Cordillera interactions than to the closure of Pangea (Ortega-Gutiérrez, 1986; Sedlock *et al.*, 1993).

We suggest that the *Neuqueniceras* assemblage is of latest Bathonian to earliest Callovian age, that the eastern Pacific *E. (Lilloettia)* species may be long-ranging and that *Reineckeia* s.l. may have appeared earlier here than in Tethys and derived from *Neuqueniceras.*

NOVEMBER 20: CHILPANCINGO-OLINALÁ-HUAMUXTITLÁN—ITINERARY

GENERAL GEOLOGY ALONG THE ROUTE

The section between Chilpancingo and Olinalá (Figure 1) cuts through a rough part of the Mixteco terrane in the Sierra Madre del Sur physiographic province; this province here consists mainly of Cretaceous and Tertiary supracrustal marine and continental strata. At Olinalá, on the other hand, a complete stratigraphic column of the Mixteco terrane is nicely exposed, from the crystalline tectonostratigraphic units of the Acatlan Complex through the late Paleozoic, Triassic(?), Jurassic, and Cretaceous essentially sedimentary marine sequences, and a Tertiary volcano-sedimentary continental cover. Since the Miocene, the region has been subjected to uplift and erosion.

From Chilpancingo to Olinalá (Figure 1) the main towns that will be crossed along the paved road are: Tixtla (at 16 km), Chilapa (at 54 km), Petatlan (at 102 km), Atlixtac (at 110 km), and Tlatlauquitepec (at 131 km). About 14 km from this last town we take a dirt, all-season road to Olinalá, distant only 38 km from there.

Three major Tertiary lithologic sequences are exposed between Chilpancingo and Tlatlauquitepec (Figure 1). In addition, the mid-Cretaceous carbonate deposits of the Morelos-Guerrero Platform and the terrigenous of the Late Cretaceous Mexcala Formation are also cropping out. The road roughly cuts the regional stratigraphy from younger to older units.

Federal Road 92 Chilpancingo-Tlapa-Piaxtla runs its whole lenght within the Mixteco terrane, across a rugged mountainous country, carved from an early Tertiary peneplain that has been rised a minimum of 2,000 m since the late Oligocene. The main stratigraphic suites exposed along the the road are from base to top 1. Acatlan Complex: A polyorogenic metamorphic unit of Devonian or earlier age, which constitutes the basement of the Mixteco terrane. 2. A Jurassic-Cretaceous unconformable sedimentary sequence of marine and continental red beds, deformed gently at the end of the Jurassic and again in the latest Cretaceous. 3. A Tertiary volcanosedimentary succession of continental red beds and calc-alkaline volcanics. Elsewhere in the Olinalá region and in other areas not traversed by this road, early Mississippian to latest Permian marine and continental deposits overlie the Acatlan Complex.

The Excursion leaves Chilpancingo on late Cenozoic lacustrine, thinly bedded strata exposed in the first mile of the trip. This unit rests with angular unconformity above Eocene coarse beds of the Balsas Formation, here composed of limestone conglomerate in thick strata tilted up to 45° and locally more, with a thickness of several hundred meters. Volcanic strata, equally tilted, occur usually above the conglomeratic unit; this stratigraphic relation is maintained throughout the area.

The town of Tixtla, 14 km from Chilpancingo, is seated on soft clastic marine sediments of the Late Cretaceous Mexcala Formation, that here it rests above badly altered and brecciated carbonates and evaporites of the mid Cretaceous Morelos Formation, which is firstly exposed about 4 km from Tixtla. Morelos Formation will dominate road outcrops for the next 15 km or so.

After the towns of Zoquiapan-El Durazno, outcrops of Morelos, Mexcala, and Balsas Formations may be seen along the road before they are covered by the volcanic sequence that composes the higher topographic points of the road, and will be reached after about 84 km from Chilpancingo. At the watershed, conglomerates of the Balsas Formation, here dominated by pebbles of the Acatlan Complex are exposed, and will do so until the town of Petatlan at the bottom of a major effluent of the Balsas River.

The ascent to a new mountain range and up to the towns of Atlixtac and Mesones, we will traverse mainly the Tertiary volcanic sequence until the first outcrops of the Acatlan Complex, which are cut by the road, about 30 km after the town of Petatlan.

The metamorphic sequence will continue as far as the village of Tlatlauquitepec and further out for about 10 km where, right at the junction with the earth road that leads to Olinalá, it is covered by sandstones of Middle Jurassic age.

CHILPANCINGO VALLEY

The Chilpancingo valley is filled up of about 200 m of alluvial fan deposits (conglomerate, sandstone, and siltstone), of continental and lacustrine facies (de Cserna, 1965). The sequence contains Miocene to Pleistocene fossils. Recent normal faulting is locally tilting the sequence. This is the youngest unit of the Tertiary section.

CHILPANCINGO-TIXTLA

Those fan deposits are in fault contact with probably Eocene-Miocene volcanic and volcaniclastic rocks, that crops out where the road starts going up to the ranges. The sequence has a thickness of more than 2 km and consists of volcanic and volcaniclastic strata of andesitic to rhyolitic composition. The unit was probably related to an extinct continental arc, developed above the subducted Farallon plate, rather than to the present Cocos plate.

TIXTLA-CHILAPA

The Cretaceous marine sequence of the Morelos-Guerrero Platform is exposed between Tixtla and Chilapa (see map 1). The sequence is composed of massive brecciated carbonates (limestone and dolomite), and evaporites (gypsum). The carbonates are underling terrigenous sediments of Late Cretaceous age (Mexcala Formation). The limit between the Morelos-Guerrero Platform and the Mixteco Terrane is approximately located close to Chilapa. As discuss before, whether the platform was developed onto the Guerrero terrane or the Mixteco terrane is still uncertain.

CHILAPA-TLATLAUQUITEPEC

Stop 1

Between Chilapa and Tlatlauquitepec, the exposed sequence consists of over 1 km of red continental conglomerates tilted through angles of 0 to 80°, with predominant values of 30 to 50° towards the west. Clasts in the conglomerates pertain almost totally to the underlying Cretaceous limestones, or to the

metamorphic basement in their lower levels and western exposures. They reflect an epoch of strong vertical movements that almost inmediatly followed the Laramide orogeny. This clastic sequence is regionally known as the Balsas Formation of Paleocene-Eocene age (see Figure 2), and it is conformably covered in this area by more than 2 km of volcanic and volcaniclastic strata of andesitic to rhyolitic composition, probably related to an extinct continental arc developed above the subducted Farallon, rather than to the present Cocos plate.

The unconformably underlying Cretaceous sequence is formed along the section by brecciated carbonates (limestone and dolomite) of massive structure included, between two sequences of terrigenous units of Early (several lithostratigraphic names) and Late Cretaceous (Mexcala Formation) ages respectively; these are, however, rarely exposed along the route.

The first metamorphic outcrop along the road is cut about 22 km after the town of Atlixtac (we will not stop here) and continue, partly covered by the Tertiary volcanics, up to the road junction leading to Olinalá.

DIRT ROAD JUNCTION-OLINALÁ

Between this last point and Olinalá, the section cuts abundant outcrops of the Acatlan Complex, Tertiary volcanics, and a Jurassic sequence of continental origin.

Stop 2

We will stop briefly along this road to examine an outcrop where the Cosoltepec Formation of the Acatlan Complex shows the basaltic, pillowed upper part of an ophiolitic complex, interpreted as slices of unsubducted ocean floor tectonically incorporated into the accretionary prism that forms the main part of the Acatlan Complex.

Stop 3

A second stop on this road will permit a panoramic view of the general structure and stratigraphy of the Olinalá area (Figures 2 and 3).

STOP 4

The contact between the Acatlán Complex and the late Paleozoic Los Arcos Formation (Corona-Esquivel, 1981) is exposed right at Olinalá over the road to Mexteopan. Rocks of the Los Arcos Formation rest unconformably on top of the Acatlán Complex. A basal conglomerate, made up of fragments derived from the Acatlán Complex (mica-schist, quartzite, chlorite schist). This is follow by interbeded siltstone, and black shales that contain abundant fossils. The fauna assemblages are similar to those found in Coahuila (northern Mexico), as well as some faunas from Sicilia and Asia (González *et al.*, in press).

STOP 5

The middle and upper parts of the Permian section are croping out at this stop. Massive limestone with abundant crinoids, brachiopods, corals and fusulinids. The sequence changes to interbedded shale and sandstone, and massive sandstone that contains ammonites, and coal fragments at the top.

The Permian Los Arcos sequence is covered by Las lluvias Ignimbrite of possible Triassic age. This volcanic, pre-Mid Jurassic unit overlies with an erosional suface the late Paleozoic sequence described above. The Cualac quartzitic conglomerates, of possible Jurassic age coover both sequences by an erosional unconformity as well.

STOP 6

General view of the Cualac anticline.

Cualac Conglomerate

This is the type locality of the Cualac Conglomerate whose name derives from the village that can be seen in the valley. The Cualac Conglomerate consist of some 500 m of thick-bedded conglomerate composed of milky-quartz clasts in quartzitic matrix. For to its resistance to erosion, it occupy the highest prominences of the area, such as the La Carbonera sincline and the Cualac and Xalmolapa anticlines.

A Middle Jurassic age (Alenian) has been assigned to it according to its stratigraphic position below the ammonitiferous layers of the Tecocoyunca Group that overlie it transitionally.

STOP 7

Tecocoyunca Group (Middle Jurassic), lower Cretaceous red beds (Tlaquiltepec) and Teposcolula Limestone (middle Cretaceous)

Between Xalmolapa and the Cañada de Huamuxtitlán, three units are exposed, distinct in age and lithology.

The Tecocoyunca Group consists of a sequence of layers of continental origin in its lower part, marine intercalations in its middle part and completely marine, plenty of Middle Jurassic ammonites in its upper part. Its thickness is greater than 500 m. It comprises the Zorrillo, Simón, Taberna, Otatera and Yucuñuti formations, which are easily recognized for its lower topographic expression and its notorious bedding due to the contrast between its resistant and non-resistant beds.

Early Cretaceous (Tlaquiltepec) red beds

This unit lies unconformably over the Tecocoyunca Group. It has a thickness of 250 m and consists of a medium-bedded sequence of thin- to medium-grained light-brown sandstone and yellowish siltstone, which in his middle part includes a milky-quartz conglomerate with limonitic matrix. An Early Cretaceous age was assigned based on the fossils *Terebratula* sp., *Lamellatychus diday* (Concuand) and *Lamellatychus angulicostatus* (Peters)?

Caliza Teposcolula

In the proximities of the Cañada de Huamuxtitlán thick-bedded layers of microcrystalline gray and light to dark brown limestone are exposed. They are related to the transgression of the middle Cretaceous, which took place in most part of Mexico.