Summary of geological history

Special attention was paid to faulting. Several minor faults have been described and others may have been overlooked. But in comparison with other similar ranges, the absence of longitudinal and transverse faulting of any importance is striking.

The Chicontepec Mountains partly excepted, all the mountain-ranges correspond to anticlines or anticlinal thrusts, the valleys being synclines in Mendez Marls. Thus the anticlinal structure is visible in the distance, as is the case with the young Iranian Ranges along the Persian Gulf.

V. Summary of Geological History.

We recognise the following phases in the history of the Sierra Madre Oriental:

1. Pre-Mississipian orogeny.
2. Denudation and submergence.
3. Deposition of the marine Peregrina Formation (Carboniferous). Filling of the basin with continental sandstones and conglomerates of the Red Beds (Permian).
4. Pre-Jurassic uplift and denudation. Removal of part of the Red Beds. So far as known, no intense folding took place, the contact with the Mesozoic strata showing only local unconformities.
5. The Mesozoic submergence seems to have occurred earlier in the south (Tamazunchale), where the fully marine Jurassic sediments accumulated in great thickness. In the north (Victoria) they are differently and poorly developed. The gypsiferous lagoon-beds of Nuevo Leon are regarded as Jurassic by BAKER, and this may be the case with the Olvido Formation of Victoria. Marine Jurassic is known farther north in Nuevo Leon, and the Victoria region may have been an island or peninsula during part of Triassic and Jurassic times. W. STAUB (1939, p. 348) calls it the Peregrina Horst.
6. In Lower and Middle Cretaceous times the sea spread all over the area, with striking facies-variations. By itself, the Tamaulipas Limestone with its rare ammonites would be taken for a deep-water deposit, as by MUIR (1936, p. 94), while the rudistid-facies is certainly a warm, shallow-water deposit. But in the region of mixed facies, the two types alternate so much that it would be hard to explain the difference on the basis of varying depth alone. Here we meet the same problem as in the Upper Jurassic of the Swiss Alps *(Quintnerkalk-Troskalk)* (ARN. HEIM in ALB. HEIM 1916—1919, II, p. 287).
7. Above the Middle Cretaceous, a break of sedimentation separates the Tamabra from the overlying beds over a large part of the area. In the north, the inner and southern ranges, where the San Felipe is fully developed, the break is not uniform and might be explained by interruption of sedimentation without emergence. But on the eastern border of the Front Ranges, for 125 km between Gomez Farias and the Rio Tampaon, there is a gap, corresponding to Turonian and Coniacian, with the Mendez Marls resting on a roughly weathered or solution-eroded surface of rudistid-limestone (Textfig. 4). If the Tamabra here showed the Tamaulipas facies, we might suppose the gap to be due to submarine solution. But the coincidence of the break with the neritic, sub-reef facies of the Tamabra, and with overlying conglomerates and breccias, clearly points to shallow-water and emergence during part of Turonian-Coniacian times. The same phenomena are presented by the well-records of the great Dos Bocas-Alamo oil-fields (Southern Fields).

In the Panuco (Northern) oil-fields the San Felipe, though always present, is thinner on the anticlines than in the synclines. These results, deduced from a few well-records in 1925, are amply confirmed by MUIR (1934, 1936). The simplest explanation is that slight submarine folding commenced in Middle Cretaceous times. This folding was very gentle in the Northern Fields where no angular unconformity has been observed. If this explanation is correct, the earliest fold in the Front Ranges between Victoria and Tamazunchale corresponds to the long, gentle El Abra Range from Gomez Farias to Taninul. Possibly similar gentle folding occurred at La Pila along the inner Colmena Range.

In Turonian times, the region of the Front Ranges partly emerged (break and conglomerates on east side of El Abra Range and at Jaumave). But the sea prevailed where the Xilitla Formation with its bituminous, siliceous limestone-flags and fish-scales was deposited. In contrast to the warm-water conditions of the rudistid-limestone, the Xilitla Formation is regarded as being deposited in a cold current, at moderate depths.

8. In Coniacian times a general subsidence occurred, during and after which the marly limestones with foraminifera of the San Felipe were deposited. The typical San Felipe beds are regarded as deep-sea deposits.

9. Throughout the Front Ranges and their foreland, the Senonian is characterised by quiet, uniform, geosynclinal deposition. The Mendez Marls, of the type of recent calcareous and blue muds, were deposited along the continental slopes. This facies, with its abundant small foraminifera, strikingly resembles the synchronous, deep-water deposits of the Helvetic Alps *(Amdener Mergel)*.

The Tamasopo Limestone-facies of the Sierra de Xilitla has not been sufficiently studied to comprehend its conditions of deposition.

10. The close of the Cretaceous Period has been regarded as marked by a break. But in our area, no distinct break has been observed below the Tertiary Chicontepec Series, the Tamesí with a wealth of foraminifera forming a transition-series.

11. In Eocene time, an enormous amount of calcarous mud and sand was washed down from the interior into the subsiding fore-deep. They formed the marine Chicontepec and the following Tertiary deposits of the Tampico region.

12. The main folding of the Front Ranges is post-Chicontepec or post-Paleocene. It terminated before the lava-flows of the unfolded mesas, whose present elevation is due to recent uplift.

VI. Petroleum-Relations.

Surface Indications.

From Victoria to the San Luis Potosi railway, rare indications of petroleum are known in the Front Ranges. We may mention the odour of the Tamabra Limestone, which is sometimes more like that of petroleum than of sulphuretted hydrogen. The Xilitla Beds, with their fish-scales, have a distinctly bituminous smell, though in the northern region not exactly that of petroleum. Oil could certainly be produced in minor quantities by distillation. But chloroform-tests give only a slight brown colour, if any. At Ojo de Agua, south of Quintero, the hollow chambers of rudistids in the Tamabra are covered with black calcite-crystals. Their black crust was first taken for asphaltite, but it is insoluble in chloroform and is carbon derived from the rudistids. At El Abra quarries, the same rudistid-