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Artikel: The front ranges of Sierra Madre Oriental, Mexico, from Ciudad Victoria to Tamazunchale
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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-

cavities occur in the miliolinid-limestone. Some contain not only calcite and carbon, but also volatile yellow oil of an aromatic smell. At Guerrero, small cracks, filled with asphaltite, have long been known in the grey Mendez Marls.

In the Chicontepec Mountains, a slight smell of oil was noted locally in the Tanlajás Sandstone. At Santa Cruz, north of Tanchanaco, two seepages were reported. Both were found dry but are located on Xilitla Beds with a slight smell of oil. The Xilitla region is rich in natural indications of oil *(chapapote)*. So far as seen, they all occur in the Xilitla Formation or the dense limestones of San Felipe facies which alternate with black, bituminous beds. In a small quarry on a ranch, SE of Tlamaya, semiliquid, darkbrown oil fills cracks in dense San Felipe Limestone. Liquid oil is reported from a hole about 1 km farther west. The same type of seepage occurs on the trail between Cristiano and Tenexcalco, again in cracks of dense limestone, interbedded with black, bituminous Xilitla Beds.

Thus the petroleum-occurrences are of four types:

(a) Liquid oil in the Abra Limestone in fossils (El Abra).
(b) Oil exuding from shaly, black, bituminous Xilitla Flags, in place of its origin (Buena Vista and Santa Cruz).
(c) Dark brown oil in cracks in dense, grey limestone of San Felipe type with *Globigerina*, in the passage-zone between Xilitla and San Felipe Beds (Tlamaya, Cristiano).
(d) Asphaltite in cracks in Mendez Shale, in secondary position (Guerrero).

Thus along the Sierra Madre Oriental, there are two primary oil-formations, the Tamabra and the Xilitla.

Sulphur-Water.

Like oil-seepages, sulphur-waters are only found in the southern part of the Front Ranges, at: (a) Palmas, on the eastern border of the Sierra del Abra; (b) Taninul, in a spring rising at the contact between rudistid-limestone and overlying Mendez; (c) Los Bañitos, 10 km SE of Valles, from boulders of San Felipe limestone; (d) Agua Hedionda, NW of Tancolol, rising from black soil above San Felipe Limestone.

Drilling.

Among borings of tectonic interest, we may note:

Santa Isabel No. 1, drilled in 1914 to 1400 ft (Pl. XVIII, Sect. 14), on a San Felipe dome, a little south of its apex. The nearest outcrops of highest San Felipe or basal Mendez show dips of 20° to SW. Coarse, black, crystalline, miliolinid-limestone was encountered between 440 and 740 ft. It is unknown whether this represents the Xilitla. Below 740 ft, typical Abra Limestone was found with a strong flow of sulphur-water.

Huitzalté. This boring, at the mouth of the San Pedro Valley encountered San Felipe with a show of oil at 3328 ft, and black platy crystalline limestone with black chert (Xilitla ?) at 3706—3910 ft. The true Abra Limestone was reached at 3960 ft and drilled to 4028 ft. Until 1925, this was the only drilling in the San Pedro district to reach Tamabra (Pl. XVIII, Sect. 14). The oil, found under high gas pressure in the well is of light yellow colour, rich in benzine, and of density 0,78.

San Pedro Valley. The best well was La Labor No. 1, though located some 100 m NE of the anticlinal apex. Oil was struck at 3870 ft in San Felipe

Beds (passage to Xilitla?). It is light brown, rich in benzine, and of density 0,796. The well flowed 30—40 barrels per day.

San Pedro No. 1 was the second best. High-grade oil was found in the San Felipe from 3650 to 4000 ft. In July 1925, drilling was continued at 4155 ft. Samples of San Felipe type-beds with green shale were collected by the writer.

Guerrero No. 1, on the Rio Tamuin, started in Mendez Beds. According to MUIR (1936, pp. 64—65) the base of the underlying San Felipe occurs at about 2421—2450 ft and the top of the grey cherty Tamaulipas Limestone at 2813 ft.

Rodriguez. In this well, 10 km NNW of Guerrero, MUIR (1936, p. 43) records a mixed facies of Tamabra, at 1906 ft below sea-level, at a distance of 8 km east of the Sierra del Abra.

Origin of Oil.

Practically all the oil in the Tampico Fields comes from the Tamabra, Xilitla and San Felipe Formations. The last, however, is non-porous and only a horizon of secondary impregnation, the oil from below filling cracks. As stated above, the Xilitla is regarded as a typical source-rock. But no locality is known where important production comes definitely from the Xilitla. Possibly the light oil in the San Felipe of San Pedro originates in the Xilitla Flags.

It has long been known that the major production in the Tampico region comes from the Tamabra Limestone. But the primary source of the oil is not definitely decided on by oil-geologists. The writer's view of 1925, at the time much contested, that the primary source is the Tamabra itself seems to be adopted by MUIR (1934). Under specially favourable conditions of non-oxidation, its organisms were transformed into oil. Along the border of the Front Ranges (Sierra del Abra), however, the greater part of the organic substances has been oxidised and evaporated, or has been transformed into carbon.

Accumulation is generally anticlinal, but is also connected with faults or igneous intrusions. The initial production of one well on the anticline of the Southern Fields is only rivalled in the Caucasus. (Total production of Potrero del Llano No. 4, 1910—1928, over 100000000 barrels.) This enormous accumulation is due to primary porosity and cavities in the rudistid-limestone. In the Northern Fields, however, the Tamaulipas-facies prevails and practically the only space within this dense limestone is related to fissures and fracturing (induced porosity of MUIR). What organisms have been transformed into oil in the Pánuco Fields and from what horizon remains an open question.

VII. Appendix.

Notes on the Inner Ranges west of Victoria.

The road from Jaumave, on the Rio Guayalejo SW of Huizachal, to Palmillas crosses a double anticline of the Sierra de los Ebanos, with its eastern limb overturned (Textfig. 9—10). At Paradita, on the western limb, we find beds, 1—2 m thick, of more or less oolitic Tamabra limestone, formed largely of fragments of algae resembling *Lithothamnium*. A second anticline is crossed east of Palmillas, the great westerly dipping walls of Tamabra forming a mountain-range. They are joined, according to W. S. ADKINS, by vertical San Felipe Beds