THE PALANGANA SALT DOME, DUVAL COUNTY, TEXAS.¹

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INTRODUCTION.

Palangana is one of the more newly discovered salt domes of the Texas Gulf Coast. The basin-like depression from which it derives its Spanish name of "Washbasin" has long been known. The early settlers were attracted to camp there because of the presence of one of the rare ponds of the region. The pond, however, is now dry. Palangana is without oil or gas seeps, paraffine dirt, mineral springs, or surficial dome, and so until within the last few years its character passed unrecognized. Attention was finally drawn to it through its proximity to the old shallow field on the Piedras Pintas Salt dome. The Sinclair Oil and Refining Company finally drilled it and by going into salt proved its salt dome character.

LOCATION.

Palangana is in southern Texas, in the east central part of Duval County. (See Fig. 58.) It is about 110 miles due south of San Antonio, and about half way between Laredo and Corpus Christi and a little north of the line connecting those two points. It is best reached from San Diego, from which it lies 15 miles west, or from the small town of Benavides, from which it is 6 miles north. Both points are on the Texas Mexican Railroad. Palangana is four miles north-northwest of the old shallow oil field of the Piedras Pintas salt dome.

PHYSIOGRAPHY.

Palangana lies in the Gulf Costal Plain, on the edge of a cuesta which is upheld by a phase of the Reynosa. From the

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crest of the cuesta, there is a gently rolling upland surface sloping faintly eastward. Within the general vicinity of Palangana, it is deeply incised by San Diego Creek, Taranchua Creek, and Santa Gertrudis Creek, and their tributaries, but further to the eastward becomes flatly rolling with shallow valleys. West of the cuesta, there is a gently rolling region of low, rounded hills

FIG. 58. Sketch map showing location of Palangana salt dome.

and shallow valleys. The general elevation of the crest of the cuesta is 500 feet. That of the hill tops of the lower lands to the west is around 400 feet, and that of the valley bottoms is around 350-375 feet. The cuesta scarp comes in from the southwest, and south of Benavides bends eastward and becomes the

south scarp of the Santa Gertrudis valley. A mile east of Noleda, the scarp on the north of the valley bends to the north to become the cuesta scarp and takes a northwesterly course, concave around the Piedras Pintas Salt Dome and convex around Palangana.

The surficial expression of the Palangana salt dome is a circular ring of low hills surrounding a central, circular basin. The diameter of the floor of the basin is 8,000 feet. The diameter of the ring of hills, from crest to crest, is 15,000 feet. The crests rise 50-80 feet above the floor of the basin. On the East and the West, the hills of this circular rim slope rather quickly down to the level of the western lowlands. On the northwest, north, and east, they are separated from the uplands of the crest of the cuesta by a partial ring of valleys concentric with themselves and the central basin. On the northeast they slope quickly down into the valley of the Taranchua. They are broad flat-topped hills which rise to the general level, or slightly below it, of the upland of the cuesta crest. The floor of the basin is not a simple plain but is divided on a north south line through the center by a pair of low, shallow ridges. The basin is drained by a valley which breaches the rim on the southwest and empties into Piedras Pintas Creek.

There are three hypotheses that can be brought to explain the present surficial expression of Palangana.

1. That it is essentially the result of the warping of the present general land surface.
2. That it is the result of differential erosion of beds already having a domed structure.
3. That the central basin is due to collapse of the surface consequent upon the solution of the top of the salt core. This thesis is not a third alternative, but a modification of either of the two preceding hypotheses.

The evidence favors the second hypothesis in preference to the first. The crests of the ring of hills around the basin are broad and flat-topped and except where very evidently lowered by erosion, rise to the plane of the general level of the upland

surface to the northwest and the east. From the Empire Gas and Fuel Company's Palangana No. 1 well eastward there is a drop in 6,000 feet of only five feet. From the northwest crest northwestward there is in the same distance no drop and in a slightly greater distance there is a slight rise. The flat-topped

FIG. 59. Topographic map of the Palangana salt dome.

surface of the crests of the rim furthermore is separated from the upland surface by valleys which give every evidence of being erosional. This flat-topped surface of the rim would seem to be a remnant of the general upland surface. A doming of that surface of a magnitude of 10-15 feet, a magnitude which is only slightly less than that of the doming of the surface over such

salt domes as Hockley and Hull and greater than that over the salt domes at Pierce Junction and North Dayton, might, however, be extremely difficult, if not impossible, of detection on account of the very considerable dissection of this region.

In the salt domes of the coastal district that have thus far been studied by the writer, the surficial dome present is the result of warping of essentially the present surface, and the foot of the dome coincides in position, or lies within the projection on the surface of the periphery of the salt core and cap. But in the case of Palangana, the Empire Gas and Fuel Company's Palangana drill hole No. 1 shows that on the southeast at least, the crest of the ring of hills lies outside of the outer edge of the salt core and the cap, and thus suggests that these hills mark the edges of the faintly upturned lateral beds.

Several explanations could be formulated to explain the formation of the central basin. The explanation which might be offered, namely, that it was formed, as the writer suspects that the Vinton basin may have been formed, by the relatively greater uplift of the surrounding ridge and not by a negative movement of the basin, does not seem plausible for reasons which have been discussed in the preceding paragraphs. The probable origin seems to have been by normal erosion, or by slumping consequent upon the solution of the top of the salt core. The first explanation seems more satisfactory than the second. There is no indication of faulting around the periphery of the basin. The small spur ridges that project into the basin slope gently down from the inner slope of the rim with no break of slope to indicate the presence of a fault line. None of the three wells drilled within the basin encountered the heavy rock which caps the rim and which should be found over the basin if the latter were formed by down faulting. In the eastern half of the basin there is a single depression contour marking a closed depression of less than five feet. This depression may have to be explained by a negative movement due to solution or settling, or it may possibly be explainable by a positive movement of the enclosing barrier due to the hydration of the cap below from anhydrite to gypsum.

Except for this shallow depression, the central basin is drained through the valley which breaches the southwest quadrant of the rim. Erosion through this valley would seem competent to explain the origin of the central basin.²

SURFACE GEOLOGY.

Palangana lies in the belt that is mapped as Reynosa, and that formation forms the surface rock of most of the area. It is overlain in places by the Equus Beds, and locally the Lagarto Beds of the Miocene-Pliocene are exposed beneath it. The Reynosa, according to Dumble³ usually is at the base a conglomerate with pebbles of different materials in a limy matrix. It is often indurated; in some cases tufaceous, sandy, or clayey. Above this continues a series of interbedded clays, limy sands, and sandstones with occasional pebbles, which may be identical with the Lagarto beds. The whole is capped by the Reynosa Limestone which most commonly is a tufaceous lime-rock but in places is so mixed with clay and sand as to lose that character. The Lagarto Beds consist mostly of sands and clays, but change to calcareous sand rock and in places siliceous or limy conglomerate. Below the Lagarto is the Lapara, which consists of sands and clays interbedded and cross-bedded and locally carrying porcelaneous and flintlike quartzitic material.

In the area immediately around Palangana, the conglomeratic phase is well exposed several miles to the east of the dome on the main road to San Diego. It was not seen at the dome. The intermediate series of clays and limy sands was not recognized at the dome. The limestone is much in evidence and forms the

² Since this discussion was written, information has been received that the National Oil Co.'s No. 2 Schallert encountered at 265 feet very hard siliceous beds that seemed to be dipping steeply toward the center of the dome. If this dip is that of the stratification, it would indicate that the central basin is the result of solution of the salt with the consequent slumping of the overlying beds. These beds are the result of silicification by thermal waters. It is very possible that the beds mark the upward course of these waters and not the stratification.

³ Dumble, E. T.: Geol., of Southwest Texas, *Trans. A. I. M. E.*, October, 1902.

capping of the hills of the rim around the dome and of the edge of the plateau. This limestone, especially in the way it follows the surface slopes, exhibits some of the aspects of caliche. In Taranchua Creek, Dumble found sands underlying the Reynosa which he thought might be the Lagarto Beds. There is much sand in the central basin of Palangana which may correspond with those beds. But the correlation of the sandy beds of the central basin on the strength of lithological character alone without the evidence of fossils is dubious since there is the very real possibility that beds normally deep lying have been brought to the surface, as in the case of Keechi, Palestine, and West Point. Porcelaneous and flint-like quartzitic material similar to that described by Dumble as occurring in the Lapara to the west, outcrop on Piedras Pintas and on Palangana, the National Oil Co.'s No. 2 encountered a similar flinty quartzitic rock at a depth of 60 feet and again at 265 feet.

SUB-SURFACE GEOLOGY.

A salt dome characteristically consists of a plug or core of rock salt, a thimble like cap of limestone, anhydrite, of gypsum mantling the salt core, and steep quaquaversally dipping beds around the salt core. The latter is circular or elliptical in plan with a diameter, of about half a mile as in the case of Anse la Butte, to three and one half miles by one and one half in the case of Stratton Ridge. The salt has nearly vertical sides and a relatively flat top. The flatness, however, is relative and there may be fairly steep slopes to the top of the salt. The cap may be hundreds of feet thick, or it may be practically absent, or thin on top and thick on the sides. The dip of the beds on the flanks of the dome varies with the dome and with the depth of the bed. It is in many cases around 1 in 1 but is less for the shallower beds and probably greater near the edge of the salt.

Although only four wells have been drilled on Palangana, they are so situated that it is possible to obtain a fair conception of the probable structure of the dome, and to recognize that it is that characteristic of a salt dome. Three of the wells have gone

into the salt. The Sinclair Oil and Gas Co.'s Schallert Nos. 1 and 2 both struck the salt at a depth of 845 feet (420 feet below sea level) and drilled 215 feet into the salt. The National Oil Co.'s Schallert No. 1 struck the salt at a depth of 985 feet (575 feet below sea level) and drilled 98 feet into the salt. The western part of the top of the salt is therefore flat. Across the center of the dome on an east west section there is a dip eastward of 1 in 15 to the National No. 1, and as the Empire Gas and Fuel Co.'s Palangana No. 1 had not encountered the salt or dome

FIG. 60. East-west cross-section of the Palangana salt dome. A, Sinclair Oil and Gas Co.'s Schallert No. 1. B, Sinclair Oil and Gas Co.'s Schallert No. 2. C, National Oil Co.'s Schallert No. 1. D, Empire Gas and Fuel Co.'s Palangana No. 1. E, Sinclair Oil and Gas Co.'s Gravis No. 1.

materials at 3,000 feet (2,494 feet below sea level) there is a dip between those two wells of over 1 in 3. The probability is that there is no simple uniform slope between these two wells,

but rather (see Fig. 60) there is a slope of 1 in 15 or 13 for a distance, and then a rapid change of slope to almost vertical. West of the western salt well, the Sinclair Schallert No. 1, the flat top of the salt probably becomes steeper and finally nearly vertical, as on the southeast. To the north and the south there is probably a slope similar to that to the southeast but the vertical position is assumed in less distance. The top of the salt, however, may be very irregular and it is not safe to extrapolate too far from the known data.

The position of the edge of the salt is of the utmost importance in the development of a salt dome, as it limits the inner extension of the lateral sands. It must not be conceived of as a sharp line. It is irregular and, because of the fact that the slope is steep rather than vertical, it varies somewhat with depth. In some places, as may possibly be the case on the eastern side, a relatively shallow lateral sand might be continuous with a sand above the cap. At Palangana, the position of the edge of the salt has not been well defined. It has been limited on the southeast by the Empire Gas and Fuel Co.'s Palangana No. 1 which shows that the salt does not extend as far out as the crest of the ring of hills surrounding the central basin. The Sinclair Oil and Gas Co.'s Schallert No. 1 shows that the salt is still relatively high within 800 feet of the foot of the ring of hills. The symmetry of the surficial expression of the dome is assumed to express the symmetry of the underground structure and accordingly the salt core is assumed to be circular rather than elliptical in plan. The edge of the salt, therefore, is judged to lie median in position between the crest of the ring of hills and the locus of a point 800 feet in from the foot of the hills. Accordingly the position of the edge of the salt is placed low down on the inner slope of the ring of hills. The National Oil Co.'s Schallert No. 2, now drilling, is apparently located about on the edge of the salt. The chances would seem to be about even of its hitting the salt around 2,500 feet or of its missing the salt altogether.

If there is any considerable development of cap-rock at that point it should strike it.⁴

The cap-rock is poorly developed at Palangana. In the two Sinclair Oil and Gas Co.'s wells there was 30 feet of hard, white "lime" immediately overlying the salt. The cuttings, according to Kennedy,⁵ looked as if this "lime" might be gypsum (anhydrite?). Three hundred feet above this bed, there is 17 feet of white "lime" overlain by 42 feet of "gypsum" and "mica" (probably selenite). In the National Oil Co.'s Schallert No. 1 there was 15 feet of "mica" (probably selenite) immediately above the salt. Above it 110 feet there was a 70 foot bed of "lime" overlain by 30 feet of "gypsum" and "mica." One hundred and sixty feet above the latter bed there was an 18 foot bed of "gypsum" and "mica" overlain by 22 feet of "lime rock." The correlation of these beds with those in the Sinclair wells is doubtful. The upper beds in each case seem to be correlative. The 15-foot "mica" bed of the National Oil Co.'s well may correspond to the 30 feet of "lime" in the Sinclair O. & G. Co.'s wells or it may be the 70-foot "lime" which corresponds to that latter bed. These upper beds may be genetically connected with the cap-rock in origin or they may be stray beds such as are sometimes found away from the immediate vicinity of a salt dome. It should be noted, however, that the Sinclair O. & G. Co.'s Gravis well had only two thin limestone beds. The Empire G. & F. Co.'s Palangana No. 1 encountered many thin beds of rock, some of them limestones, but the main cap rock was not encountered.

The detailed structure of the beds around the central core is

⁴ The National Oil Co.'s Schallert No. 2 was recently announced, officially, to have encountered salt at 1019 feet (574 feet below sea level). The most recent report, apparently authentic, is that the well went through 101 feet of salt and into gumbo (drillers' term for clay) at 1120, into sand at 1136, and is now standing at 1138. The salt encountered in this well may be a lense above the main salt mass or a tongue projecting out from it as at Anse la Butte. The slope of the top of the salt on the east must be much less in any case than it is shown in Fig. 60, but until more information is available, the situation will remain in doubt.

⁵ Kennedy, Wm., Report on Palangana to H. A. Speer, unpublished.

not known. Two wells have been drilled off the salt, the Empire Gas and Fuel Co.'s Palangana No. 1 on the edge of the dome, and the Sinclair Oil and Gas Co.'s Gravis No. 1 two miles to the northeast. Their logs, however, do not present any clues for correlation from the one well to the other.

A feature that is attracting much local curiosity at Palangana is a "breathing" well that was put down near the National Oil Co.'s Schallert No. 2 in an unsuccessful attempt to get water. The normal behavior of the well according to Mr. Lee, field superintendent of the National Oil Co. at Palangana, is as follows:

Morning	Sucking in
Around 9 o'clock	Quiet
Forenoon and early afternoon	Blowing out
Around 4 o'clock	Quiet
Early evening	Sucking in

Its behavior as seen by the writer was as follows:

9:00 A.M.—After a clear cool night.....	Sucking in
2:30 P.M.—Clear warm day, almost hot.....	Blowing out
4:15 P.M.—Clear warm day	Quiet
3:15 P.M.—Cool cloudy day with spits of rain.....	Sucking in

Mr. Harris a former driller on the National Oil Co.'s No. 2 adds that occasionally he has seen it sucking in at noon time and that twice at 7:30 P.M. he has seen it quiet and once sucking in.

The well blows out with a light cool breeze that is readily noticeable to the hand but that barely affects a rather stiff cotton handkerchief. The well is four inches in diameter, is 42 feet deep and is drilled in a rather porous tufaceous-looking siliceous limestone. On account of the incompleteness of the observations and the lack of the proper knowledge of the meteorological conditions, it is dangerous to draw conclusions in regard to the cause of the breathing. The control would seem possibly to be the local temperature affecting the local atmospheric pressure.⁶

⁶ For notes on breathing wells see: J. D. Harris, Geol. Surv. of Louisiana, Report of 1905, Bull. No. 1, p. 60; and E. H. Barour, U. S. G. S. Water Supply, Paper 29, 1899, pp. 78-82.

OIL AND GAS.

There are three general types of occurrence of oil on a salt dome; in the relatively flat-lying shallow sand lenses above the cap; in the rock and cavities of the limestone or gypsum cap that covers the top of the salt core; and in the lateral, steep-dipping, often deeply buried sand lenses on the flanks of the dome. The presence of the oil is often indicated at the surface by gas seeps, oil seeps, oil and gas in shallow water wells, and paraffine dirt.

On Palangana there are none of these surface indications of the presence of oil and no important shows of oil or gas have been found in any of the wells drilled on the dome. The first Sinclair O. & F. Co.'s well had no show of oil or gas. The second had a small show of oil at 398 feet. There was no notable show of oil in either the first National Oil Co. well or in the Empire G. & F. Co.'s Singer well. The Sinclair O. & R. Co.'s Gravis well had a small show of gas at 959 feet, enough gas at 1,400 feet to cause a severe blowout, and a small show of oil at 2,060 feet. Four miles south of Palangana there is the old shallow field of the Piedras Pintas dome that is still producing a small amount of oil, from 250-350 feet.

The three wells that went into the salt, the Sinclair O. & R. Co.'s Nos. 1 and 2 and the National Oil Co.'s No. 1 are sufficient to condemn the top of the dome. There are sands present above the cap but they are apparently not oil bearing. These sands probably lense in and out and there is a possibility that away from the vicinity of these three wells a local lense might be found that would prove oil bearing but the probability is extremely small. There is slight possibility, also, of there being any oil found in the cap rock. These three wells show that it is only twenty feet thick and report no oil from it.

The lateral sands might be condemned by some on the strength of the dry hole of the Empire G. & F. Co.'s Palangana No. 1. The condemnation of more than the forty acres surrounding the well, however, is not justified. The productive area of many of the salt dome oil fields is extremely small. That of so productive a pool as West Columbia which up to April 1, 1920, has pro-

duced 10,084,000 barrels of oil, is only fifty acres.⁷ Dry holes are in many cases only a stone's throw from big producers. This well furthermore was a rotary well drilled under contract. Unless extreme vigilance is used, oil may be sealed back by the pressure of the heavy column of mud and be missed. In a well drilled by contract, furthermore, there is often a tendency to drill for speed and depth and oil sands may thus be missed. The presence of oil in sufficient quantity to justify commercial extraction at Piedras Pintas shows that oil is present in the immediate vicinity of Palangana. It becomes a question of finding a sand that was favorably situated to catch and hold the oil. But as such a sand, if there is one, may have an area of the magnitude of only 50 acres, a long drilling campaign may be necessary to find it. But in this it will not differ from most of the salt-dome fields.

AGE OF THE DOME.

In Texas there are two belts of salt domes, an inland belt comprising the Keechi, Palestine, Butler (West Point), Brenham groups of salt domes, and the coastal belt comprising those nearer the coast. Largely on the basis of the stratigraphic conditions prevailing, but partly on account of the recent doming of the present surface that is manifest in the surficial mounds of many of the coastal salt domes, there is a tendency to hold that the domes of the inner belt were formed in the late Cretaceous or early Tertiary, and the domes of the coastal belt in Miocene or post-Miocene time. The recent doming of the surface can, in part at least, be accounted for by the hydration of the anhydrate of the cap to gypsum, and may not indicate any primary movement connected with the formation of the salt dome proper. The inland domes are all well dissected and in that respect contrast strongly with the coastal domes, whose surficial mounds, even in the case of such a mound as Davis Hill, rising 200 feet above the general level of the surrounding country, show the effects of but slight erosion.

Physiographically Palangana resembles the inland belt of

⁷ The field has been much extended by a well completed late in July, 1920.

domes much more than the coastal belt and may therefore be of that older age. The more considerable erosion that Palangana has undergone may, however, be due to the fact that it is more favorably situated for erosion than the domes of the coastal belt. It is apparently older than the plateau level of the top of the cuesta and the Reynosa does not seem to have been greatly affected by the doming. How much the Lagarto and Lapara Beds were affected is not known.

ORIGIN OF THE DOME.

The origin of salt domes is still a much disputed question. There is a general tendency among geologists who have studied salt domes to recognize that the salt core is intrusive. The mechanism of the intrusion is a disputed question and no satisfactory explanation of it has as yet been formulated. With the little exploration that has been done to the present, Palangana offers no new evidence on the origin of salt domes and the various theories that have been advanced⁸ will not be discussed here.

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⁸ G. D. Harris, "Rock Salt in the State of Louisiana," *Bull. No. 7, Geol. Surv. of La.*, 1907; E. T. Dumble, "Origin of the Texas Salt Domes," *Bull. A. I. M. E.*, No. 142, 1918; E. L. De Golyer, "The Theory of the Volcanic Origin of Salt Domes," *Bull. A. I. M. E.*, No. 19, 1918; G. S. Rogers, "Intrusive Origin of the Gulf-Coast Salt Domes," *Ec. GEOL.*, Vol. XIII., No. 6, 1918; F. F. Hahn, "The Form of Salt Deposits," *Ec. GEOL.*, Vol. VII., No. 2, 1912.