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The Occurrence of Gas in the Beeri-Saad Area

(Southern Coastal Plain of Israel) [1]

By H. J. TSCHOPP and GABRIEL WIENER

Abstract

A spectacular gas blowout from a recently drilled structure-hole at Beeri has attracted renewed attention to the gas possibilities in the southern coastal plain of Israel. This gas well is located on or near the crest of a Cenomanian structure. This structure is being outlined by shallow drilling in order to locate future deeptests for possible oil accumulations in the Lower Cretaceous and older formations.

The gas with a spray of water issues from a Cenomanian reservoir which is truncated by Sakieh marl (Neogene). The open flow rate was estimated at 17 million cbft/day. The most favourable gas/water ratio was obtained when production through a $^3/_{16}''$ choke stabilized at an average daily flow of 230 000 cbft of gas and about 42 bbls of water with a tubing pressure of 240 PSI.

Additional shallow holes in the Beeri-Saad Area are necessary to determine the commercial importance of this gas deposit.

I. Introduction

The mayor gravimetric maximum which extends in the southern coastal plain of Israel over a distance of 50 kms from south of Beeri [2] in a north-east direction to beyond Negba coincides with a trend of anticlinal structures en echelon whose Cretaceous culminations are buried under a considerable cover of overlapping Neogene. Oil is being produced from two of these highs at Heletz and Brur. Other structures on this trend are being investigated with the help of shallow drilling in order to locate the Cretaceous culminations underneath the Neogene.

During such structure-drilling operations in the Beeri-Saad area (fig. 1), considerable escapes of gas occurred in three of the structureholes on the Saad high but none comparable to the big gas blowout in Beeri S. H. 6 on the 16th of August, 1957. The gas blew with a spray of water through the $5\frac{1}{2}''$ casing with all the drillpipe in the hole. Later the well caught fire. After the fire was extinguished gas continued to blow uninter-

[1] Published with the kind permission of «Matsada» United Drilling Co.

[2] For location see fig. 1 of «The Oilfind of Heletz, Israel» by H. J. Tschopp in Bull. Swiss Ass. Pet.-Geol. & Eng., vol. 22, no. 63 (Febr. 1956), pp. 41–54, 2 figs.

ruptedly for 12 days with an estimated open flow of 17 million cbft/day until it was provisionally capped on August 30th.

This remarkable show of gas calls for a reappraisal of the prospects for commercial gas production in the southern coastal plain of Israel.

II. Stratigraphy

The stratigraphy of the Beeri-Saad Area, as regards as shallow gas prospects are concerned, is summarized in the following table:

Age of Formation		*Depositional Environment*	*Lithology*	*Hydrology*	*Hydrocarbons*	*Thickness*
Recent to Pleist. ?Pliocene	KURKAR	littoral	yellow to reddish SANDSTONE, some GRAVEL, yellow SAND; intercalations of sandy MARL near bottom	fresh water-aquifer, locally brackish	gas near Beeri (sulphur-quarry)	95 m to 150 m
Pliocene ?Miocene ?Oligocene	SAKIEH	marine (reducing)	grey, blue, green sticky, slightly sandy MARL with gypsum near old barriers; much pyrite dispersed; some sand lenses	impermeable	possible source-rock	150 m to 465 m
Eocene		marine	white CHALK and LIMESTONE with some flint	usually impermeable	—	0 to 140 m
Paleocene Danian		marine (partly reducing)	grey MARL and CHALK, limonitic	impermeable	possible source-rock	0 to 93 m
Senonian			grey, white and pink LIMESTONE and CHALK, some flint	mostly impermeable		
Turonian		marine	yellow and brown MARL, crystalline LIMESTONE	sulphurous brackish water where porous	gas in some shallow wells at Beeri-Saad	0 to 137 m
Cenomanian		marine, partly reef-facies	brown LIMESTONE and DOLOMITE, few MARL membres			434 m

S a k i e h is the local facies-term for blue, grey and greenish marine, slightly sandy to sticky marls typically developped in the subsurface of the coastal plain from Beersheba in the south to the Carmel mountains in the north. In some places the marl is almost black and contains finely dispersed pyrite and glauconite. Approaching the overlying Kurkar sands (mostly dune sands) the Sakieh becomes more sandy and is often interbedded

with Kurkar-like sands and sandstones of several meters thickness and of considerable lateral extension. In the lower part, presumably influenced by pre-Sakieh barriers, gypsum occurs in different forms, either as gypsiferous marls and clays or as massive gypsum in thick layers (Beeri structure-holes 1 and 7, corehole 2; Mavquiim, 7 kms northwest of Heletz; Gan Javne [2]). Near the bottom of the formation the marls often take a chalky aspect and may contain, like in some of the structure-holes at Saad, reworked Eocene foraminifera, but layers of pebbles and boulders as they are known from the Heletz-Negba area were not observed at Beeri-Saad.

The Sakieh marls have been deposited in a shallow submerging basin of possibly estuarine character in a reducing environment (pyrite content). As a whole, the Sakieh can well be a source rock for hydrocarbons.

The marls are sticky and impervious. Porous intercalations (sands, coquina) are very rare and usually rather thin and lenticular. Thicker sands are known only from immediately below the Kurkar, thus at very shallow depth. In summary, reservoir-beds within the Sakieh are either too shallow (just below the Kurkar) or thin and extremely

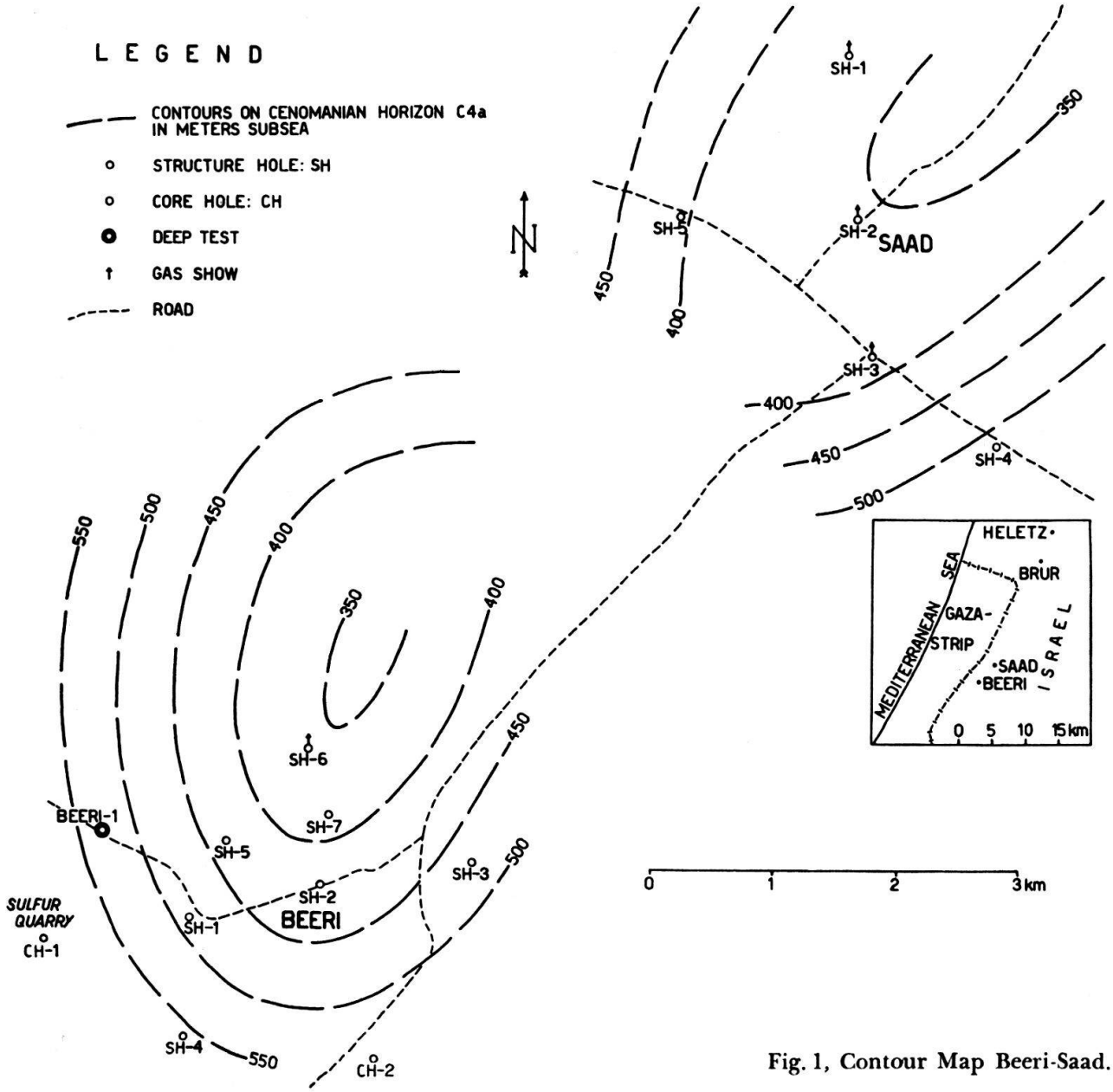

Fig. 1, Contour Map Beeri-Saad.

sporadic. However, the Sakieh thickens rapidly towards the Mediterranean Coast to over 1000 m and, therefore, may hold gratifying surprises regarding porosities in the yet unsufficiently explored areas nearer to the coast.

Foraminifera suggest a Mio-Pliocene age for the Sakieh. The marlfacies can be compared with the Plaisancian facies of Italy. The equivalent of the Astian facies (conglomerates and shell-beds) is present on the eastern border of the coastal plain. The exact stratigraphic relation of the Sakieh marl and the Astian conglomerate, however, is not yet defined.

Along the Beeri-Heletz-Negba trend the Sakieh is an overlapping formation. On the higher culminations the Sakieh rests usually on Cenomanian as illustrated by the gas well Beeri S.H.6 which shows the following log:

0—116,2 m K u r k a r, calcareous sandstone and sandy marl near the base
116,3—370,8 m S a k i e h, grey-green foraminiferal marl, slightly chalky at bottom
370,8—466,7 m C e n o m a n i a n, dolomitic limestone and dolomite

The same overlap of Sakieh on Cenomanian was observed in Beeri S.H. 2 and 7 and in Saad S.H. 1, 2 and 5.

The following formations intervene downflank between base Sakieh and top Cenomanian: First Turonian (Beeri S.H. 5; Saad S.H. 3), then Senonian (Beeri S.H. 4, Saad S.H. 4), Paleocene (in the Heletz area), Eocene (Beeri deeptest; Saad S.H. 4) and coastwards also Oligocene. The farther away from the structural culmination the more complete and continuous is the Turonian-Senonian-Tertiary section.

The Eocene which also is an overlapping formation may progressively transgress onto Turonian along the outer rim of the culmination area, as in the Beeri deeptest.

As shown on the cross-section (fig. 2), the pre-Sakieh erosion was most intensive east of the crest, contrary to Heletz where the westflank has been eroded down to the Lower Cretaceous [3].

III. Structure

The Cenomanian structure of Beeri, as far as proved by structure-drilling, is a south-plunging, slightly asymmetric anticlinal high separated from the next northern high of Saad by a saddle of yet unknown depth (fig. 1 and 2). Beeri and Saad are the two southernmost culminations of the Beeri-Heletz-Negba trend of structures which is the result of folding movements intermittently active at least from late Cretaceous to Miocene times. During the deposition of Sakieh an almost uniform downtilt to the west took place along the whole trend. This downtilt is not visible at Beeri itself. Here the thickness of the Sakieh, and in a lesser degree also that of the Kurkar, increase not only towards the west, but also towards the south and east. This increase does not necessarily indicate an uplift during Sakieh time. The Sakieh thickness of the eastflank may also be due to a valley or depression in the pre-Sakieh landsurface into which the Sakieh sea advanced around the southend of the Beeri high or across the saddle between Beeri and Saad. Thus, the Beeri culmination, possibly a shallow submarine swell or even an island, may have been separated from the eastern Sakieh shore by an embayment which gradually filled up, temporarily facilitating the precipitation of gypsum (Beeri S.H. 1 and 7 and corehole 2), and, finally, reached across and buried the culmination area with its deposits. The slight eastdip of the Sakieh/Kurkar contact, see fig. 2, may, in this case, be the result of differential compaction augmenting with depth and thickness of the Sakieh.

[3]) See fig. 2 of «The Oilfind of Heletz, Israel» by H. J. Tschopp in Bull. Swiss Ass. Pet.-Geol. & Eng., vol. 22, no. 63 (Febr. 1956), pp. 41—54, 2 figs.

IV. The Occurrence of Gas

Flows of gas are known since long from waterwells near the locality S a k i e h (also Saqiya), southeast of Tel Aviv.

Shows of gas were encountered in several structure-holes drilled by Isramco near P e t a h T i q v a [2], east of Tel Aviv. The gas occurs in sand intercalations of the uppermost Sakieh marls close to the base of the Kurkar at very shallow depth.

A gas pocket which blew out and caught fire was met in one of Isramco's Gan Javne [2] wells after drilling through a layer of gypsum little above the base of the Sakieh.

Three of the structure-holes drilled on the S a a d high had remarkable gas shows. In Saad S.H. 1 and 2 gas bubbled persistently while drilling with lost circulation in Cenomanian dolomites below the Sakieh overlap. From Saad S.H. 3 gas with water and H_2S blew during ten hours untill it could be killed with mud. The gas started to blow when the drillpipe was being lifted from a depth of 409 m in Turonian marls and chalky sandy limestone.

A «large gas escape» from oil-impregnated and sulphurbearing Kurkarsands is reported [4] from the «sulphur-quarry», 1 km southwest of B e e r i deeptest.

[4]) G. M. Lees (1950), «The Middle East» in «World Geography of Petroleum», pp. 185–200. Am. Georg. Soc., Princeton Univ. Press.

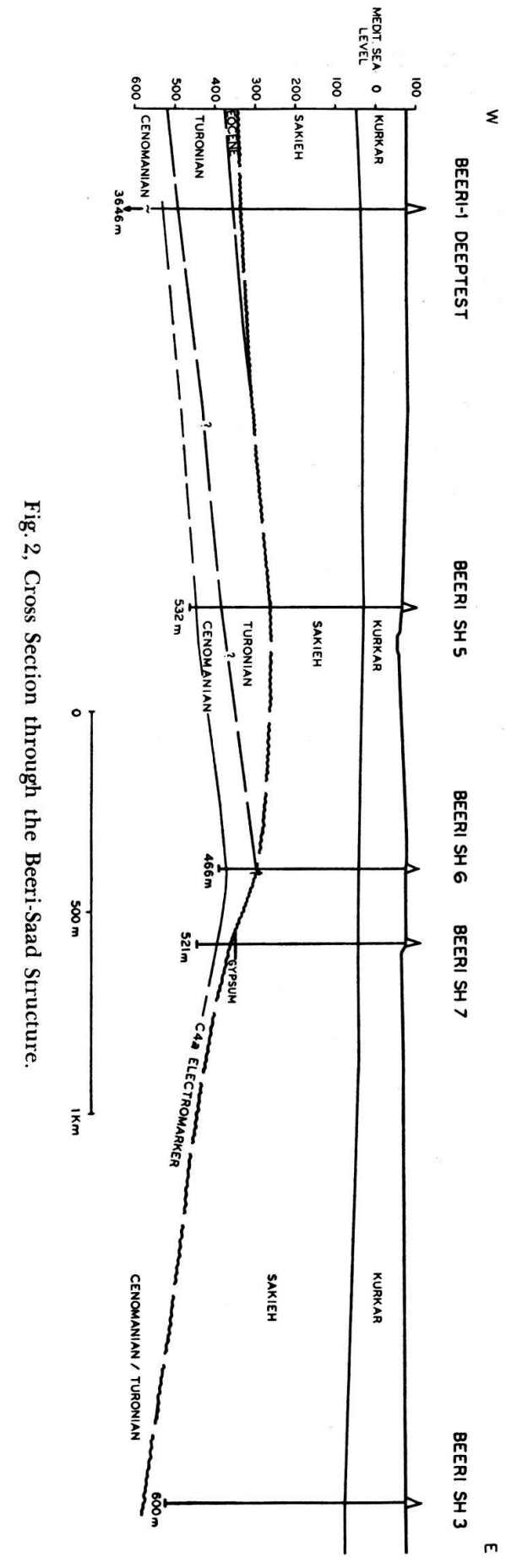

Fig. 2, Cross Section through the Beeri-Saad Structure.

The big gas blowout in Beeri S.H. 6 has been referred to before. The gas had started to blow when drilling in Cenomanian dolomitic limestone at 394 m with the circulation completely lost. After replacing the badly burnt Joy rig with an Ideco-35 the gas was brought under control with sealing material and heavy mud. Then a blowout preventer was installed, the drillpipe which had broken from the kelly of the Joy rig was recovered and the hanging 5½" casing cemented at 388 m. Finally, the hole was deepened to a total of 466,7 m. Four drillstemtests were carried out within the uppermost 20 m of the Cenomanian section, partly in open hole below the casing, partly through perforated casing. The two open hole tests made between 387,9 m and 391 m proved beyond any doubt that the Cenomanian, where circulation had been lost, carries sulphurous saline water with traces of gas. The water contains 4000 Cl ppm and was swabbed at the rate of 300 bbls/day.

The next higher test through perforated casing between 384,5 m and 386,4 m was dry. The formation seems to be tight there.

The fourth test through perforations in the casing at the intervals from 371 m (base Sakieh) to 372 m, 376,5 to 377,5 m and 380 to 381 m produced gas with a spray of water. In order to obtain the most favourable gas/water ratio this test was extended over nearly two weeks. The gas production finally stabilized at an average of 230 000 cbft per day (measured by Pitot tube) together with 42 bbls of saline water (5500 Cl ppm) through a $^3/_{16}$" choke. The bottomhole pressure was 450 PSI, the tubing pressure 240 PSI.

A provisional analysis of the gas by The Weizmann Institute, Rehovot, Israel, shows the following composition of a sour gas without higher hydrocarbons:

Methane	about 98 —99	%
Nitrogene	about 1 — 2	%
H_2S	about 0,2— 0,3	%

An additional quantity of H_2S is dissolved in the water produced with the gas.

The gas reservoir evidently lies within the uppermost 15 m of the Cenomanian, e. g. between 370,8 m (base Sakieh) and 384,5 m (top of the dry test). The sulphurous saline bottom water starts somewhere between 386,4 m (base of dry test) and 387,9 m (top of the tests yielding sulphurwater).

Because of the deepreaching pre-Sakieh erosion east of Beeri S.H. 6 (see fig. 2), the horizontal extension of the gas reservoir is probably much less extensive at Beeri than at Saad. The gas prospects of both highs deserve to be investigated by further shallow drilling.

O r i g i n o f G a s : The gas of Petah Tiqva and of the «sulphour quarry» near Beeri can only derive from the Sakieh. It is likely that the gas encountered in the structure holes of Saad and Beeri and in the Gan Javne well has the same origin. Another possible source are the bituminous members of the Paleocene-Danian-Senonian section which usually is wedged in between the Turonian and Sakieh along the outer flanks of the Beeri-Heletz-Negba trend. The association of gas and water in the Cenomanian reservoir at Beeri suggests that the reservoir originally was saturated with water and that the gas replaced it by lateral migration from the onlapping Sakieh and/or from the Paleocene-Danian-Senonian wedge farther downflank.

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