ZION OIL & GAS INC
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ZION OIL & GAS

NOTICE

Zion Oil & Gas, Inc. has filed a registration statement (including a prospectus) with the SEC for the offering to which this communication relates. Before you invest, you should read the prospectus in that registration statement and other documents Zion Oil & Gas has filed with the SEC for more complete information about Zion Oil & Gas and its offering. You may get these documents for free by visiting EDGAR on the SEC web site at www.sec.gov. Alternatively, Zion Oil & Gas or its underwriter will arrange to send you the prospectus if you request it by calling toll free 1-888-891-9466 or emailing amy@zionoil.com. Direct links to the SEC document location, or to the documents in PDF, may be found on the home page of Zion Oil & Gas, Inc. at www.zionoil.com.

NOTICE... This Project Description–2005 replaces all previous editions of Project Description or Prospect Description. This Project Description–2005 shows (i)a revised geological interpretation at Ma'anit based upon the results of drilling the Ma'anit #1(re-entry); (ii) a revised interpretation of the reefal prospect – East Joseph reefal play; and (iii) the inclusion of the new 121,100 acre Asher Permit area.

TABLE OF CONTENTS

I. Summary

Between April and October of 2005, Zion Oil & Gas drilled the Ma'anit #1(re-entry) to a depth of 4719 meters (15,482 feet) into the Scythian aged Zafir formation of the Early Triassic. The well did not encounter reefal carbonates in the Carnian aged Mohilla at this location as previously theorized. However, the well did find a significant oil and gas column in the Carnian (Mohilla equivalent), Ladinian (Saharonim) and Anisian (Ra'af) formations. The Company believes that upon final completion this well will be designated a discovery well for three or more reservoirs in a new field. This Project Description - 2005 details 1) the results of the drilling at Ma'anit and the basis for drilling a step-out confirmation well into the Triassic, 2) drilling the East Joseph Reef Prospect, 3) drilling a wildcat exploration well into the deeper but accessible Paleozoic formations, and 4) continuing geological and geophysical studies on what are very promising License and Permit areas.

In the Ma'anit #1 (re-entry) the Triassic sediments began at a depth of 3302 meters (10,833 feet) according to the consulting paleontologist, and 3282 meters (10,768 feet) by log correlation. This was considerably higher (sooner) than the forecasted depth of approximately 3850 meters (12,600 feet). Being approximately 570 meters (1870 feet) higher than expected contributed to the 1224 meter (4016 feet) interval above the oil/water contact containing nine individual zones of oil and gas reservoirs as determined by the combination of increased drilling penetration rate (drilling breaks), gas shows, analysis of rock cuttings and log analysis. Well operations are currently suspended, waiting upon the results of a step-out appraisal well in order to optimize the completion of the Ma'anit #1 (re-entry).

With the drilling of a second well at Ma'anit, the Company believes that it will confirm and develop both light oil reservoirs (± 39º API) with considerable quantities of natural gas and associated liquids and rich natural gas reservoirs containing considerable quantities of condensate. Based upon current data, the discoveries should be primarily oil reservoirs in the Ladinian, Anisian and Scythian formations and natural gas in the Carnian and Norian formations. The oil reservoirs are expected to be saturated to slightly under-saturated, water-driven oil reservoirs with the bubble point at or only slightly less than the original bottom hole pressure and having an initial gas-oil ratio ("GOR") of ± 1886 standard cubic feet of gas per stock tank barrel of oil ("scf/STB").

Post drilling analysis revealed that intrusive volcanic sills gave a seismic signature similar to that of a reef and the subsequent misinterpretation of the structure. The volcanics were unexpected at this location based upon previous work (lacking a magnetic anomaly) indicating that they would not be present. Despite the absence of the reefal carbonates, the results of the well were very encouraging and a second well at Ma'anit is justified to confirm the discoveries, as is continuing the exploration for a reef in other areas of the License particularly in the south.

With the drilling of a well at the East Joseph Prospect, the Company believes that it may find presence of commercial oil and gas production from a Carnian (Mohilla) aged reef.

With the drilling of a Paleozoic aged Permian test on Ma'anit structure, the Company will evaluate a completely new potential. The Permian is one of the best known oil and gas bearing formations throughout the world and a commercial find at Ma'anit, while unable to quantify at this time, could be extremely significant. If successful, the Company anticipates a continuous exploration and development effort over the next five to ten years in both the 98,100 acre License and the 121,100 acre Asher Permit (with priority rights - acquired in August of 2005 for a period of 18 months) which contains several promising leads based partially upon the plugged and abandoned well bore, Asher-Atlit #1 which encountered 1200 meters (4000 feet) of a Triassic aged reef.

II. Ma'anit

Previous Interpretation

The original Ma'anit prospect as postulated by Oil Fields, Ltd (Sdot Neft, the previous operator of the Ma'anit License) was based upon the presence of a large positive gravimetric anomaly without a magnetic anomaly. The absence of a magnetic anomaly resulted in the interpretation that a major subsurface magmatic body could not have caused the gravity high (as e. g. at Asher-Atlit) but rather, the feature was probably a deep-seated, old structure. The geological concept of pursuing this prospect - based on the then available seismic and drilling data - consisted of a Triassic paleo-topographic high of an old, roughly a N-S trending elongated threshold, the so called Gerar horst, and high energy near- shore sediments, where porosity could be expected, separating a low energy lagoonal basin to the east and a low energy open sea deposition to the west.

After acquiring a license in 1994, Oil Fields carried out various exploratory works including detailed gravimetric modeling, shooting of four seismic lines and both surface and subsurface geological mapping, in order to clarify this anomaly and develop the concept. In 1995, Oil Fields drilled an exploratory well on this anomaly; however, the targeted Triassic formations were not reached due to lack of funds. Drilling was suspended at 2335 meters (7661 feet) in the Middle-Upper Jurassic Haifa formation without encountering hydrocarbons.

In 2000, Zion Oil and Gas, Inc. acquired the license area and expanded the scope of exploration as new information became available from neighboring wells and more recent seismic profiles. The Company also shot two additional seismic lines. The results of the interpretation of the new data corresponded with the geological concept on which further exploration was based.

This concept was composed of a) sedimentological paleo-environmental, b) structural, and c) petroleum system model considerations:

a. During late-Triassic - Liassic time, the central part of Israel was divided into three roughly north-south trending major tectonic-sedimentary features: the Judea-Samaria-Galilee trough on the east, the slope of the Levant basin on the west, and between them extended a long uplifted ridge, the Gerar mega-horst. This general tectonic framework greatly influenced the sedimentation during late Triassic and Liassic times. In the eastern trough, lagoonal sediments, mainly anhydrites and dolomites were deposited (Ramallah, Debora and lately the Meged wells) whereas in the west, low energy open sea slope sediments were encountered (as it was found in Ga'ash #2). In the central platform high energy carbonate grainstones, oolithic shoals and/or reef trends were anticipated. Consequently, the Ma'anit area was considered to be favorably situated with respect to finding reservoir-type rocks in a structurally high position in the late Triassic and possibly in the Liassic.

b. Structurally, the Ma'anit area is situated on the central mega-horst and uplifted during late Triassic -Liassic time. As stated, the positive gravimetric anomaly at Ma'anit was interpreted as an indication of a deep-seated old high. However, the question of separation from the Umm-el Fahm structure caused some concerns regarding structural closure. The Umm-el Fahm anticline, unlike Ma'anit, belongs to the late Cretaceous Syrian arc system. The Ma'anit mapping displayed a closed structure and the relevant seismic sections showed a fault of significant throw down-to-the-east thus confirming the separation of the two structures.

c. Rather recently, Paleozoic (Silurian) aged oil in the Triassic was identified by Givot Olam in their Meged #2. Silurian sediments were hitherto unknown in Israel. In central and northern Israel no well has ever reached the top of Paleozoic, let alone the Silurian level, so positive source rock definition is not possible at this stage.

However, from burial curve studies it appears that petroleum generated in the Silurian reached maturity and migration phases long before the onset of the late Cretaceous (Syrian Arc Compression) folding period, thus it would have reached the Ma'anit structure when it was a dominant paleo-topographic high ready to receive it with the possibility of reservoir rock and an areally extensive seal.

The newly discovered possible oil source combined with the probability of finding reservoir quality beds on the high energy platform in the Triassic section on a Mesozoic high were the considerations which made the Ma'anit prospect a world class prospect.

Forecasted Findings

The anticipated geological column to be penetrated at Ma'anit follows:

Top of the Jurassic Haifa Fm. was found at 1825 meters (5988 feet) well depth. The new, deepened well was expected to continue to drill in the Haifa formation containing predominantly limestone with minor shale with volcanic interbeds.

The top of lower Jurassic Nirim formation was forecasted at 3000 meters (9843 feet). This unit was expected to consist mainly of carbonates and the Asher volcanics near the base.

The top of Triassic was predicted to be encountered at 3850 meters (12,640 feet). The Shefayim formation (Norian) composed of shale and anhydrite was expected to be approximately150 meters thick. The top of the main target, the Mohilla formation (Carnian) was forecasted at 4000 meters (13,124 feet), and built of high energy sediments, probably reefal limestones. Older Triassic stages, Ladinian, Anisian and Scythian, consisting of dolomite and limestone with minor shale intercalations were expected to continue to 5000 meters (16,404 feet).

Actual Findings

The findings of the deepened Ma'anit #1(re-entry) presented several surprises. (See figure 1 on the next page) First, the top of Triassic was encountered much higher (shallower) than predicted, 3282 meters (10,769 feet) well depth instead of the 3850 meters (12,640 feet) as forecasted. Second, unpredicted volcanic interbeds turned out to be intrusive of early Cretaceous age. Third, the presumed reef in the Mohilla formation was not seen. The geological interpretation of the findings of Ma'anit #1(re-entry) are summarized below:

Structure:

The well proved the previous mapping in that it was located in a dominantly high position at top Triassic level, near the culmination of an anticline. The axis of the Ma'anit anticline is situated in N-S direction and its structural closure is over 1000 meters. The anticline is bordered by a large fault on the east and has strong structural dip to the west. It is supposed that the eastern fault is an old fault associated with the Triassic-Liassic uplift. The distance between the fault and structural closure is approximately 7 kilometers. Another fault, the continuation of the Wadi Ara reverse fault, bisects the Ma'anit structure, decreases in throw and seemingly dies out westward. A third fault lies to the SSE and the combination of the faults and structural closure gives the feature a horst-like appearance.

The question of Ma'anit being the continuation or plunge of the Syrian arc type Umm-el-Fahm anticline seemingly has been answered negatively for several reasons:

a. There is a definite separation between the two structures. The Ma'anit anticline has a pronounced eastern flank and also a fault with a considerable eastern throw at top Triassic level.

b. The axis of the Umm-el-Fahm anticline trends to the ENE, the Ma'anit axis to the North.

c. The truncated upper Triassic and the partly missing Liassic indicate that the Ma'anit structure already existed by the end of the Triassic, whereas the Umm-el Fahm structure was folded in the late Cretaceous. There is no information on the top Triassic at Har Amir #1, as the well drilled on the Umm-el-Fahm structure reached total depth while still in middle Jurassic. But the well confirms this anticline as being a Syrian Arc type structure by the direction of its axis, its asymmetrical flanks, and a reverse fault along its steep flank.

d. The Wadi Ara fault, which runs along the steep NNW flank of the Umm-el-Fahm anticline, - having been formed in consequence of the folding during the Syrian Arc Compression - bisects the Ma'anit anticline near the culmination of the structure. Whereas at Umm-el-Fahm, it trends parallel with the axis. At Ma'anit it is perpendicular to the axial trend. From the current mapping it appears that the Wadi Ara fault has a horizontal right-lateral component as well as the reverse throw.

Figure 1 - Triassic Structure at Ma'anit

Stratigraphy:

The geological formation tops are shown below and in Table 1 following:

Table 1 - Ma'anit #1(re-entry)

>Geological Age and Formation Tops

A description of the local stratigraphy at Ma'anit can be seen within the broader scope of the regional stratigraphy in Appendix 1.

Hydrocarbon Potential:

The Triassic dolomite reservoir in the structural trap of Ma'anit closure combines not only secondary porosity from the dolomite but includes enhanced fracture porosity. Samples of asphaltum technically referred to as 'pitch glance' were recovered from the Triassic dolomites along with gas and condensate in the well cuttings while drilling clearly demonstrate that there are hydrocarbons in the Ma'anit well. In addition, the "pitch glance' indicates that the fractures in the wellbore may vary in width from 1 mm to at least 13 mm. Complimenting this optimism, were increased drilling rates in the Triassic (suggesting porosity and fractures) and sustained oil and gas shows in the Triassic from 3400 meters to 4611 meters.

Based solely upon the drilling data, the hydrocarbons appear to be in a thermogenic column with light gas on top grading downward gradually into a gas with condensate or light oil with associated gas.

The

Company believes that the following summary table is a conservative approach to the recoverable hydrocarbons in the Ma'anit #1(re-entry). The log calculations were performed by Forrest A. Garb & Associates, Inc. using the following: a) 40% water saturation cut-off, b) 6%) porosity cut-off and c) R_w: Carnian--.033 Ladinian--.030 Anisian--.028

Table 2. Ma'anit #1(re-entry)

Pay Interval Summary

		Top of	End of	Data	Porosity	Average	Gross	Net	Gross	Net
Sequence	Cut-off	pay (m)	Pay (m)	Points	Avg	H_20 Sat	Pay (m)	Pay (m)	Pay (ft)	Pay (ft)
Carnian 3390 to 3855 meters (Sharon or Mohilla equivalent)										
Carnian 1	6%	3829.0	3831.8	19	6.1%	23.2%	2.7	2.7	9.0	9.0
Carnian	6%	3829.0	3831.8	19	6.1%	23.2%	2.7	2.7	9.0	9.0
Ladinian 3855 to 4145 meters (Saharonim)										
Ladinian 2	6%	3903.4	3905.8	17	8.1%	34.4%	2.4	2.6	8.0	8.4
Ladinian 1	6%	3986.5	3998.1	47	7.5%	33.2%	11.6	7.2	38.0	23.5
Ladinian	6%	3903.4	3998.1	64	7.6%	33.5%	14.0	9.7	46.1	31.9

Anisian 4145 to 4560 meters (Givanim and Ra'af)										
Anisian 8	6%	4163.9	4169.4	13	8.8%	23.2%	5.5	2.0	18.0	6.5
Anisian 7	6%	4206.1	4223.7	14	8.2%	27.4%	17.7	2.1	58.0	7.0
Anisian 6	6%	4241.1	4266.5	83	7.4%	27.6%	25.4	12.7	83.5	41.5
Anisian 4	6%	4292.9	4313.5	49	8.1%	16.2%	20.6	7.5	67.5	24.5
Anisian 3	6%	4321.5	4327.8	30	8.1%	25.6%	6.2	4.6	20.5	15.0
Anisian 2*	6%	4343.9	4358.4	24	7.4%	35.1%	14.5	3.7	47.5	12.0
Anisian	6%	4163.9	4358.4	213	7.8%	25.2%	90	32	295	107
Summary of nine sections with log calculated pay:										
Carnian	6%	3829.0	3831.8	19	6.1%	23%	2.7	2.7	9.0	9.0
Ladinian	6%	3903.4	3998.1	64	7.6%	34%	14.0	9.7	46.1	31.9
Anisian	6%	4163.9	4358.4	213	7.8%	25%	89.9	32.5	294.9	106.6
				296			106.7	45.0	350.0	147.5

*

Current perforations 4345 - 4351.1 meters

Figure 4 - Schematic of Ma'anit #1(re-entry) Wellbore in Triassic Interval

Ma'anit Prospects

The horst block in the center of the Ma'anit structure comprises approximately 3500 acres that is considered to be the prospective area for the purposes of calculation hydrocarbon potential in the Carnian and Ladinian. Because of the distance to the oil/water contact, the Anisian is prospective over 2000 acres and the Scythian about 500 acres. The Company intends to drill the Ma'anit appraisal well with a bottom hole location located on Shot Point 130 of seismic section DS-0586, approximately 475 meters north-northwest of the Ma'anit #1(re-entry). All of the targets listed below will be seen in the well bore as can the Permian target (discussed in subsequent section IV).

Figure 5 - Detail of Structure at Ma'anit
Showing the Proposed Ma'anit step-out well

Norian

At Ma'anit, the uppermost Triassic formation, Norian [3282 to 3390 meters], has an abbreviated section having been truncated by pre-Jurassic erosion along with the younger Rhaetian. In other parts of the License the Norian is expected to be shales, marls and marine limestones. At Ma'anit it is generally a dense dolomite. In the Ma'anit #1(re-entry) gas shows were observed during drilling and the interval appears to be gas saturated by log analysis, but porosity is quite low and the section is not considered to be a primary objective unless the porosity increases or there is significant secondary fracture porosity due to a closer proximity to the Wadi Ara Fault. Based upon the increase in fault activity associated with the Wadi Ara fault as seen in the shallow Judea Group, the Company intends to drill the Ma'anit appraisal well north of the Ma'anit #1(re-entry) to encounter the fault pattern in the Norian.

Carnian

The Carnian (Mohilla equivalent) [3382 -3855 meters] is a primary target at Ma'anit. Gas shows with heavy components were prevalent throughout most of the section beginning at 3489 meters

(11,447 feet) and continuing to the base. The interval from 3771 - 3861 meters (was characterized by thirteen drilling breaks of between 2.5 times and as high as five times the normal drilling rate. Each drilling break was accompanied by chromatograph readings of C_5+. Log analysis failed to show significant porosity over 3%.

When casing was set in the well, it was decided not to place cement over the zone from 3771 - 3861 meters. The reasoning being that cement might fill the fractures and eliminate any chance of production from the 90 meter fractured interval. It was only later, after swabbing a considerable amount of water that the Company realized the water was coming out of the intrusive Cretaceous volcanics. Attempts were made to seal off the water by remedial cement squeezes, but these were only partially successful.

One three meter interval calculated more than 6% porosity and less than 40% S_w. Called the Carnian 1, the zone is from 3829 - 3832 meters (12,562 - 12,571 feet).

As is the case with the Norian, the Company intends to drill the Ma'anit appraisal well north-northwest of the Ma'anit #1(re-entry) to encounter the fault and fracture pattern believed to exist at that location.

During completion the volcanics will be isolated from the prospective zones. Other than the Carnian 1 zone, the upside hydrocarbon potential is unknown for this interval as a considerable portion of the gas would be coming from fractures and potentially from zones with greater than 40% water saturation and less than 6% porosity. Several long intervals have both fracture porosity and 3 to 6% porosity with water saturations between 40 and 50%.

Ladinian

The Ladinian (Saharonim) [3855 - 4160 meters] was not known previously to be productive in Northern Israel but is highly prospective on the Ma'anit structure. Apparently secondary dolomitization in conjunction with the high energy depositional environment gave this formation sufficient porosity to become reservoir quality. The cuttings in this zone indicated that the hydrocarbons could be gas/condensate or light oil with associated gas. The Gevanim in the lower Ladinian and upper Anisian is non-prospective as it consists primarily of shale and volcanics.

Anisian

The Anisian (Ra'af to Upper Zafir) [4160 - 4500 meters] is perhaps the most prospective oil interval at Ma'anit. In the Ma'anit #1(re-entry), while drilling between 4340 to 4350 meters, oil was seen on the mud pits and both the chromatograph and cutting fluorescence indicated producible oil. The 200 meter (650 foot) section calculates to contain 16 meters (51 feet) of net pay.

Scythian

In the Scythian (Lower Zafir) [4500 - 4719+ meters] is an alternating shale, limestone and dolomitized limestone interval, which contains porosity in the dolomitic sections. The Company encountered a two meter drilling break and

oil show at 4611 meters as recorded with a gas chromatograph reading which was characterized as a "textbook case" by the well site geologist. Due to hole difficulties only a gamma ray was obtained over the interval which appeared to be four meters in thickness from 4611 to 4615 meters (15,128 to 15,141 feet). It is believed from the drilling that the oil-water contact occurred in this section at 4613 meters (15,135 feet). Based upon the seismic, it appears that at this level the Ma'anit appraisal well will be 10 to 50 meters high to the Ma'anit #1(re-entry). By being structurally higher to the Ma'anit #1(re-entry) additional pay sections could be encountered in the Scythian.

III. JOSEPH CARBONATE BUILDUPS

The Joseph Reef prospect is located near and on the southeastern boundary of the License on the coastal plain. Consequently, the quality of seismic is somewhat improved over Ma'anit although still impeded by the existence of the shallow Kukar fossilized sandstone which attenuates the seismic signals. Because of several limitations with the seismic in the License area itself, the better quality, defining seismic line DS-3064 is actually located just south of the License in the west and crosses the most southerly portion of the License. On this line, two carbonate buildups (Joseph and Joseph East) can be postulated which when correlated with the other seven seismic lines that define the buildup indicate that the two features are actually two distinct highs on a single large carbonate buildup located to the north and substantially within the License.

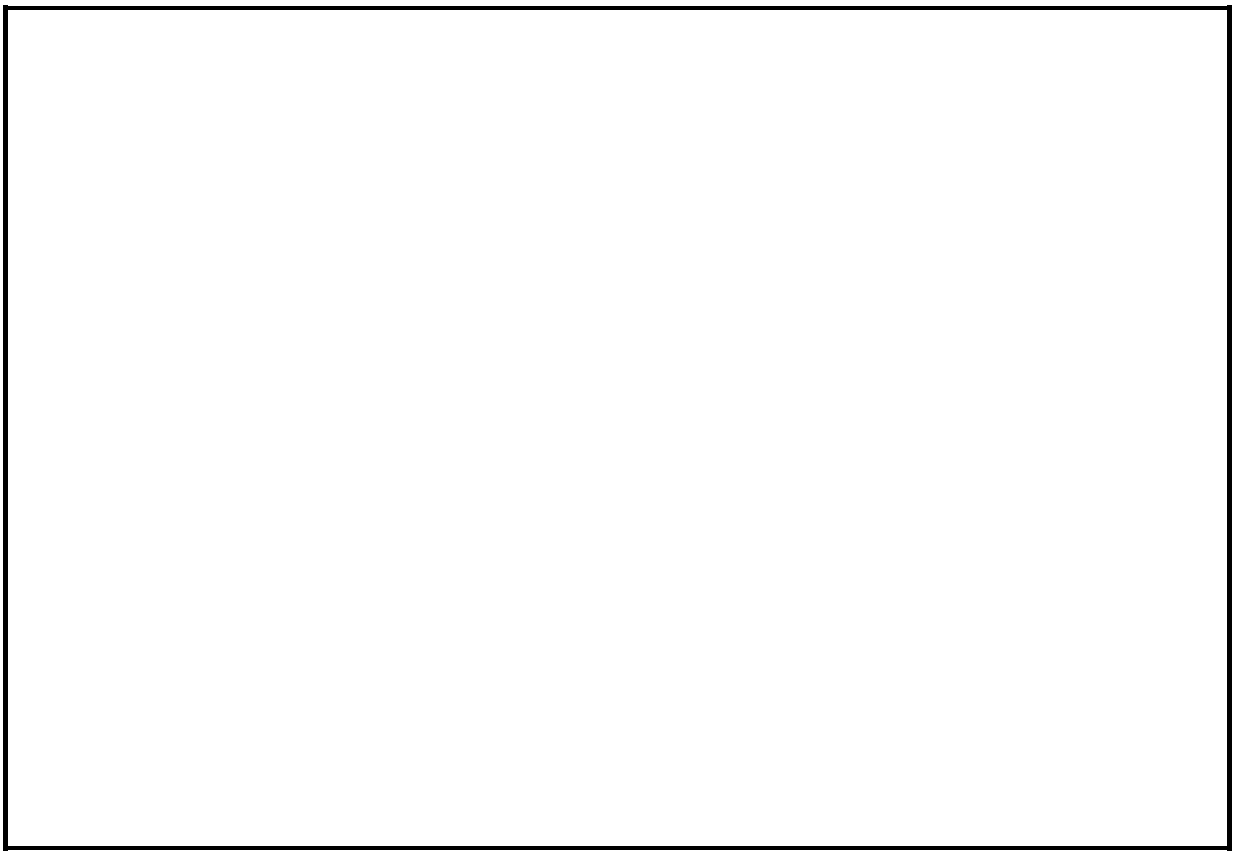
The East Joseph Reefal prospect is the more prospective one in that, from the seismic records, all of the characteristics of a reefal buildup are present. The Joseph Reef is strictly a stratigraphic prospect located on the East-West Mezosoic high and not having structural enhancement due to the folding caused by Syrian Arc Compression as at Ma'anit.

The West Joseph prospect is a structural/stratigraphic buildup in the high energy zone in the shallow marine environment directly west of the East Joseph. It is possible that the West Joseph prospect pinches out on the East Joseph reef.

The drilling location (Joseph #1) into the East Joseph Prospect is at approximately 188.5 North and 140.8 East (Israeli Coordinates) in a position that is expected to be structurally high to Givot Olam's Meged #4 located approximately 13 kilometers (8 miles) south of the East Joseph prospect and encounter the thickest point of the postulated reef (based upon current information and interpretation). At that location, the top the East Joseph Reef is expected at approximately -4100 meters SS (-13,130 feet SS) and encounter between 275 and 300 meters of gross reef (900 to 1000 feet).

The East Joseph Reef prospect encompasses a total area of almost 4000 acres within the License area.

Fig. 6 Isochron/Isopach of the East Joseph Carbonate Buildup



IV. PERMIAN

Additional targets, the Paleozoic Saad and Arkov formations of the Permian are leads throughout the License but occur at much deeper depths than the Triassic targets. However they appear to be located on the same paleo-topographic structural high, as seen on the seismic lines over the Ma'anit structure. At Ma'anit, the top of Permian is expected to occur between 4800 and 4900 meters (15,750 to 16,075 feet), within the depth capability of the drilling rig that drilled the Ma'anit #1(re-entry).

The presence of a fracture system, deeper Silurian aged oil seen above the Permian, the Ma'anit structure and the Permian's reputation as being a prolific oil horizon around the world make the Permian an enticing target. The structural closure is expected to approximate the closure seen at the Triassic level. The seal for the Permian is thought to be the dense limestones and shales of the Early Triassic as seen at the bottom of the Ma'anit #1(re-entry) lithologic log.

V. ASHER PERMIT

The Asher Permit issued in August of 2005 for a period of 18 months with priority rights to convert into a license is composed of 121,100 acres lying adjacent to and north of the Ma'anit/Joseph License.

Figure 7 - Combined License and Permit Area

Preliminary mapping in the southern portion of the Permit area indicates that one or more Triassic aged structures may exist above the known oil/water contact as seen at Ma'anit. In addition, the reef which was encountered in the Asher-Atlit well may extend to the east across the major down to the west fault and be seen at much shallower depths than in the Asher-Atlit #1. The lateral extent and depth of the reef is a complete unknown at this time. Much more geological and geophysical work will be required to identify and quantify specific prospective areas within the Permit.

VI. APPENDIX

A1. Current Stratigraphic Interpretation

Basement

Since no well in Northern Israel has been drilled below the base of Triassic, identification of the deeper formations is highly speculative. However, two regional markers appear on most of the seismic and have been used by Zion Oil & Gas to identify what is possibly a basement marker and a Paleozoic marker of approximately Permian age or perhaps a little older. In the License, Permit and adjacent areas, the "basement" marker can be found on most seismic lines at approximately 3+ seconds and has been interpreted to occur at depths of ± 8000 meters (± 26,000 feet) to over 10,000 meters (± 33,000 feet). However, on many seismic lines deeper reflections appear that would indicate that the "basement" marker is actually higher in the geologic section, possibly Cambrian While the main axis is roughly N-S paralleling the present coastline, secondary E-W axes also exist below the present Triassic highs at Ma'anit and Joseph.

It is the Company's intent to undertake a comprehensive study of the basement in Northern Israel using aero-mag survey data combined with the existing gravity data. The positive identification of the basement will then be tied into the seismic profiles thus enabling the Company to better identify the Paleozoic structures above the basement.

Paleozoic

The Paleozoic is characterized by numerous seismic reflections indicating a variety of depositional environments. Most notably, the License is located on a Paleo-high as evidenced in seismic interpretation by the wedging and on-lap of the Paleozoic strata onto the Paleo-high and the relative uniform thickness of the Triassic formations between the Ga'ash #2 well to the southwest and continuing north-northeast through the License into the vicinity of the Ma'anit #1 where the trend appears to bend in a northwest direction toward the Asher-Atlit #1. On top of the basement high, the Paleozoic has the minimum thickness of approximately 1500 meters (5000 feet). The Paleozoic highs virtually mirror the Basement highs. To the east, the Paleozoic section thickens into a basin, called the Galil Rift by Givot Olam. The major faulting occurs on the east and west sides of the high giving the appearance of a horst block.

At Ma'anit, the top of Paleozoic is expected to occur as shallow as 4800 - 4900 meters. On other local highs within the license are it appears to be at 5400 meters or deeper. In most of the License area the top is anticipated to be below 6000 meters.

Triassic

The Eastern Mediterranean Mesozoic Basin originated by intracratonic crustal extension along what was to become the African Coast, across the present Levant coast and Syria to the margin of the Neo-Tethys Ocean (May, 1991). During the Triassic, the eastern blocks in Syria and Turkey diverged from Arabia producing the Triassic basin of Syria, Jordan and Israel. In northern Israel, this gradual subsidence amounted to over 1000 meters in the Triassic (Druckman, 1974).

The Triassic basin, still an embayment of the Proto-Tethys Ocean, was centered in Israel and southwestern Syria. The Permian-Triassic sequence is cyclical beginning with clastics in the Upper Permian or Lower Triassic and terminating in a regional unconformity. Three lower order cycles can be distinguished:

I) An Early to Middle Triassic cycle that culminates with Anisian limestone (Ra'af Formation)

2) A prominent regional cycle that culminates in Carnian evaporites (including the Mohilla Formation).

3) A possible Upper Triassic (Norian - Rhaetian) carbonate cycle that is incomplete due to pre-Jurassic erosion.

In terms of general litho-facies patterns, the Arabo-Nubian massif was shedding clastics as in the Sinai and Egypt where the Triassic is comprised of non-marine clastics. In Israel, Jordan and Syria the marine Upper Permian-Triassic sequence begins with sandstones, dark shales and carbonates and is succeeded by a carbonate-evaporite series. Open marine conditions possibly existed to the northwest (Druckman, 1974). Salt and anhydrite were deposited in the rifted Palmyra region of Syria. In the vicinity of the Ga'ash well a structural high is present that, according to some, formed the silled edge of the basin in which the evaporitic Mohilla was deposited. The sill separated the inner basin from open marine conditions to the west. As such it would be situated adjacent to the open marine basin in a position where one could readily expect reefal growth to take place.

Middle to Late Triassic experienced a general warming with an overall rise in sea level while experiencing some transgressive - regressive cycles. The Company postulates that during this time, the Upper Triassic-Mohilla-aged reefs grew primarily due to a classic case of eustasy.[1] In general, the growth rate equaled or exceeded the rise in water level, resulting in the formation of the Joseph Reef Prospect located substantially within the License area.

A Late Triassic-aged reef of at least 1200 meters (4000 feet) was encountered in the Asher-Atlit #1 (Deepened) located approximately 22 kilometers north-northwest of Ma'anit #1. In this well, which finished drilling in 1983, drilling was terminated at 6531 meters (21,431 feet) in the Upper Triassic due to very high drill pipe torque caused by a highly fractured formation. Due to hole problems and the eventual loss of the well, a suite of logs is not available. A direct structural connection between the Asher-Atlit #1 and the License area is postulated but not conclusive due to the geological complexity of the Atlit area.

The complexity is the result of 1) the apparent very thick Late Triassic, Carnian - Norian, section comprising over 1200 meters, all of which is thought to be deposited in a reefoidal environment resembling the Triassic of the Dolomite Alps, 2) the anomalous depth, 3) the intrusive Liassic and Cretaceous volcanics as well as concurrent Triassic volcanics, and 4) Early Jurassic rifting. The overlying thick Jurassic volcanic section, acoustically masking the Triassic makes seismic resolution extremely difficult. In the attempt to resolve the obvious differences between the Asher-Atlit #1 and the interpretation at Ma'anit #1, Zion Oil & Gas noted the presence of the Triassic-Liassic down to the west "Atlit" fault on seven seismic lines:

Zion Oil & Gas enlisted the expertise of Mr. Frank Stoakes, a noted worldwide expert on reefs, located in Calgary, Canada to make a report on his interpretation of the Triassic. A portion of the Stoakes Report text is quoted below:

"Triassic Reefs

Triassic reefal bodies are well known through spectacular outcrops in the Southern Alps of Italy and Northern Alps of Austria. They have been studied for many years as models of fossil reefs. The great development of major

carbonate banks was in Middle Triassic time but a repetition of the shallow water, marine bank facies also occurred in the Late Triassic (Bossellini, 1988). These occurrences relate to reefal growth in the Tethys Ocean close to the Triassic paleo-equator.

The reefal banks of the Dolomites are measured in several kilometres and grew to a thickness of 700 to 1500 metres dipping into their adjacent basins with slopes of 10 to 30 degrees.

The Triassic marked the re-establishment of the shallow water coral reef builders (Schleractinean hexacorals) which colonized the shelf breaks of large, often evaporative shelves. These calcareous organisms were the main frame builders of the high-energy breaker zone.

1e.g. Vail, et at., 1977; Hag et at., 1987

Depositional Setting of the Mohilla Formation

The Mohilla is an areally extensive dolomite-evaporite succession generally devoid of fossils and often exhibiting cryptalgal lamination and fenestral (birdseye) structures. The evaporitive component is mainly gypsum and anhydrite. As such, it suggests restricted sedimentation under warm, arid to semi-arid conditions characterized by chemical sedimentation of carbonate (fine grained dolomite) and evaporite (gypsum and anhydrite). Thin grainy and/or oolitic levels represent short-lived open marine incursions. Two depositional settings have been proposed for the Mohilla:

Silled Basin (Garfunkel and Derin, 1974; barred basin of Hassan, 1963) Evaporitic sedimentation behind a seaward barrier is a common phenomenon in the rock record. Initially, these basins were open marine and are characterized by isolated reef developments. These buildups became encased by evaporitic deposits that accumulated behind the main barrier. As the main seaward barrier grew to sea level, circulation was reduced and the basin became elevated in salinity and evaporative sedimentation took place in the inter-reef areas. Evaporative drawdown (dropping sea level in response to evaporation) meant that these sediments had relatively shallow water characteristics. An idealized depositional cycle is comprised of a lower laminated unfossiliferous fine-grained dolomite (the first chemical sediment) which passes up into a laminated gypsum or anhydrite. This package defines a brining-upward cycle and is generally capped by a finegrained dolomite of the next minor inundation. Because these cycles reflect basinwide transgressive and evaporitic events, they are often highly correlatable over large areas and in the absence of core are most readily discerned on density logs. The most restricted inboard portions of the sub-basin may also contain halite (true rock salt). Although gypsum is invariably the evaporitic mineral first produced in the subaqueous setting it quickly reverts to its anhydrous variety, anhydrite, with burial.

Silled basins are often marked by rapid thickness variations with areas of lower subsidence marking the sill and more subsiding areas the hypersaline basin. This would certainly explain the significant thickness variations seen in northern Israel.

Key criteria for the recognition of a silled basin evaporite are:

a) Widely correlatable dolomite-anhydrite brining-upward cycles.

b) Dolomites and anhydrites show primarily depositional laminations.

c) Rarely relict gypsum crystal structures are found. Because silled basin evaporite deposits occur in restricted but shallow, hypersaline situations they can often be rich source intervals. This is because algal blooms can form in surface waters and because of the lack of infaunal burrowers all of the organic material produced is preserved. Source intervals, however, are difficult to detect because they are very thin but rich. Oils derived from a hypersaline source often have a characteristic geochemical fingerprint."

The Asher-Atlit #1 confirms the existence of reefal structures. The Company contends that the Asher-Atlit #1 reef is not isolated but rather one of a series of intact reefs that edged the silled basin to the east. There appears to be agreement in the work by Korngreen at the Asher-Atlit #1 and Givot Olam in the Meged #2 supporting the silled basin hypothesis. Based upon Korngreen's[2] detailed study of the Asher-Atlit #1 cuttings and Givot Olam's study of its Meged #2, the area may have experienced several transgressive - regressive cycles in which the reefs possibly drowned and then began to rebuild.

Using facies shifts and the early diagenetic history of the carbonate sediments, Korngreen subdivides the Triassic of the Asher-Atlit #1 into six major cycles of sedimentation, each terminated by shallowing, exposure, and drowning. Three cycles appear to be solely the effect of volcanic activity whereas three could be the result of sea level fluctuations and/or volcanic activity and related subsidence.

[2]Korngreen, D., Benjamini, Chaim, 2002, Ben Gurion University, Beersheva

Givot Olam, on the other hand, uses anhydrite beds to identify the regressive cycles in the back reef subsiding basin. In the Meged #2, Givot Olam divides the Carnian (Mohilla) formation into two regressive cycles interrupted by a major transgressive cycle that may have had some minor regressive cycles included.

Despite the overall rise in sea level during Middle-Late Triassic the back reef basin was generally evaporitic further suggesting the presence of a barrier reef system.

During transgressive cycles some of the reefs would have eroded, providing reefal detritus found in the Meged wells and further south in the David #1 at Modi'in.

Jurassic

In general, the Jurassic section is well documented and the stratigraphic sequence is not particularly relevant to this Project Description. Only the events that have not been described in other works are included. For most of the License area, the Jurassic is of a relatively constant thickness, varying between 700 to 800 milliseconds (2000 meters or 6500 feet) on the seismic sections. Only at Ma'anit does the interval thin to 600

milliseconds (1500 meters or 4900 feet).

Seismic sections indicate the presence of a major western bounding fault of Triassic-Liassic age. This "Atlit" fault appears to separate the Asher Volcanics from the platform sill. Seismic also indicates that the Early Jurassic Asher Volcanics were deposited contemporaneously with the final stages of the faulting, probably enhancing it, as it is postulated in the Asher-Atlit #1 well. It is believed that the faulting and the volcanic activity are tectonically associated. From the seismic it appears that Caesarea #3, - also on the down-thrown side of the "Atlit" fault, - penetrated most of the Jurassic interval and at its total depth was close to encountering the volcanic section. Seismic

evidence shows that the appearance of the Asher Volcanics is restricted to the down-thrown, western, side of the Triassic-Liassic Atlit fault. It is noteworthy that the Lower Jurassic thickens considerably west of the Atlit fault, mainly because of the additional volcanic section, whereas there are no significant variations in the thickness of the Middle-Upper Jurassic section other than at Ma'anit.

Cretaceous

In general, the Cretaceous section is well documented and the stratigraphic sequence is not relevant to this Prospect Description.

During Late Cretaceous - Early Tertiary, Syrian Arc Compression caused by movement of the African Plate forced many of the regional structures to "invert". In areas, old faults, with the right orientation, were re-activated and inverted. Downthrown blocks became upthrown making the Jurassic structurally high to comparably aged rocks on the old highs. This is evident in the structural position today of the back-reef basin area as is evidenced in the seismic and maps in the appendix. In the License this Jurassic high is to the northeast of the Paleozoic-Triassic high.

Exploration efforts in the past (Har Amir #1, for example), assuming that the oil was generated in surrounding shales or migrated from the Levant basin, resulted in the drilling of dry holes into the current highs of the Late and Middle Jurassic. At Rosh Ha'Ayin in the Meged #2, Givot Olam drilled on the Jurassic high into the deeper, older Upper Triassic-Mohilla-aged formation where the Silurian oil was discovered in non-commercial quantities. The Company believes that the Meged #2 was located on the current Jurassic high caused by the Syrian Arc Compression.

Early Cretaceous was a period of intensive volcanic activity as demonstrated by the wide spread Tayasir volcanics. While primarily extrusive in the Cretaceous, the volcanics were also intrusive into the Triassic both at Asher-Atlit and Ma'anit. The southern extent of the intrusive volcanics is unknown, but they are not present in either the Meged wells southeast of the Ma'anit License or the Ga'ash #2, southwest of the Ma'anit License.

A2. The Petroleum System Model

Source Rock

Until the work done by the Givot Olam Ltd Partnership commencing in 1993, the major source of oil was believed to exist in the offshore Levant Basin (modern Mediterranean Sea). Oil was thought to have been generated in and migrated from the organically rich rocks of the Jurassic. The oil migrated out of the basin onto the elevated Coastal Plain of Israel. Integration of geochemical data with stratigraphic and structural data led to the conclusion that all the oils in the southern Coastal Plain derive from the Barnea Formation, deeply buried to the west of the oil fields. Detailed geochemical and isotopic analysis of the organic matter contained in the Barnea Formation and the oils of Heletz-Kokhav, Ashdod and Ashqelon indicate that all are genetically related.[3] Most of the exploration used this model to search for oil and gas, hence the intensive efforts in Southern Israel in the Cretaceous, Upper and Middle Jurassic.

Givot Olam, on the other hand, hypothesized that a major oil source had been overlooked - the Middle East Paleozoic Petroleum System. Tuvia Lushkin believed that the Palmyra Rift containing a prolific source rock of Silurian age extended into Israel. The Silurian shales supply much of the oil found in North Africa and the Middle East including nearby Syria. Based upon his geo-chemical studies, he believed sufficient Total Organic Carbon

("TOC") existed to generate billions of barrels of oil or equivalent gas in Israel.[4]

Givot Olam then proved the existence of the Silurian oil by drilling the Meged #2 and Meged #4 in License No. 244/Rosh Ha'Ayin approximately 30 kilometers (19 miles) south-southeast of the License. Both wells discovered non-commercial oil accumulations in Upper Triassic (Mohilla formation). Independent studies conducted on samples of the oil sent to Geomark Research, Inc. in Houston, Texas confirmed the oil found by Givot Olam as being Silurian, comparable to some oils found in the Middle East and North Africa.[5]

From seismic data, the License appears to have thick Paleozoic formations between the Triassic and basement rock. The Company believes that it can expect to find

similar oil or gas-condensate as seen in the Meged #2 and Meged #4 of Givot Olam.

Alternatively

, barring the presence of a Silurian source rock, a strong possibility exists for a suitable source in the shales and carbonates of the Triassic. In the Ga'ash #2, Amit (1981) examined two samples of asphalt, one oil show and two samples of black shales from the Triassic succession in the well in an attempt to determine a possible relationship between them. She concluded that the asphalts are probably not related to drilling additives (Soltex) and likewise they are not related to the oil or the shales. On the other hand, the oil show may be related to the Triassic black shales, although the correlation is not conclusive.

The following is quoted from the abstract of the report of Gvirtzman, et al (1984), concerning the results of the geo-chemical study for the Ga'ash #2.

"The Triassic sequence of Ga'ash #2, (which is) 948 meters thick, is composed of dolomites and limestones interbedded with dark and variegated shales .... The entire section, one third of which is composed of shales and two thirds of carbonates, is potential source-rock. The average TOC of the shales is 1.26% and of the carbonates 0.78%; the total weighted average is 0.93%. According to studies of vitrinite reflectance and thermal alteration index of exinites, the sequence is situated within

[3]From Bein and Sofer, 1987; Alimi and Kaplan 1987
[4]From givot Olam website - www.givot.co.il. While the Company believes that there may well be sufficient TOC in the Silurian formation to generate enough hydrocarbons, no well has penetrated the Silurian formation in Israel and, to its knowledge, there have been no geo-chemical studies on the shales, if they exist as postulated by Givot Olam.
[5]From Givot Olam web site www.givot.co.il

the oil window and the lowermost 250 meters is within the gas zone (Ra'af). The hydrocarbon potential of the source-rock was estimated by two independent methods. The "total oil" potential of the section, estimated by the kerogen-type method, varies from 16.7 to 32.5 million barrels of oil per square kilometer area around the well. This wide range is due to different quality factors attributed to some alginitic sapropels as well as other phytoclast found in the sequence. The total oil potential estimated by the rock-eval pyrolysis method is 72.5 million barrels per square km area. A mid-value of about 33 million barrels is believed to be the most probable.

...As a result of catagenesis up to the present level of maturation, 85% of the "total oil" has already been generated. .... An analysis of a burial curve together with time-temperature-indices ("TTI") and $\%R_o$ values, leads to the conclusion

that the period of "most intensive oil generation" of the source-rock varies from Hauterivian to Recent."

Burial Diagram of Ga'ash #2 with TTI and % R_o Values

Also, a potential third source rock was postulated in the Stoakes Report as being the algal blooms commonly found in the hypersaline back reef basin. While this source has not been seen in Israel, there also has been no effort to identify it in the cuttings of the deep wells of northern Israel and the Ma'anit #1(re-entry) did not encounter the back reef basin sediments.

The Ma'anit #1 did not define the source rock and at this point any of the above could be possible. It is the intent of the company to do an extensive geo-chemical analysis of the oil once good samples can be obtained.

Migration

The drilling of the Ma'anit #1 confirmed that oil migrated into the structure. Time of migration appears to be prior to the intrusion of the Cretaceous volcanics, probably late Jurassic as the intrusive volcanics, which probably sealed the limestones and dolomites upon intrusion are filled with water whereas the surrounding carbonates are hydrocarbon bearing.

Structure

The conventional wisdom in Israel, as detailed in numerous studies following the generally unsuccessful exploration attempts to the Middle Jurassic, is that prospective oil fields must be located upon old Paleo-topographic Highs ("Paleo-highs"), thus insuring that, given the timing of migration, the oil would find a ready trap in these structures. This theory appears to hold at Ma'anit where oil did migrate into a paleo-high prior to the Syrian Arc Compression.

The Ma'anit #1 is structurally and stratigraphically the highest well in Northern Israel at the top of Triassic. Despite the thin Norian section the well is 500 meters high to the Meged #2, located near the crest of the Rosh Ayin Structure. The extent of the structure makes the overall potential excellent from Triassic through the Permian of the Paleozoic.

Reservoir

The reservoir quality has always been the largest risk in Israel. The drilling history of Israel is replete with oil and gas shows in non-reservoir quality rock.

Generally, the Carnian (Mohilla) formation in Northern Israel is anhydrite and dense dolomite (non-reservoir quality) found in the back reef basin as seen in the deeper wells such as Ramallah #1 and Deborah #2a (both of which saw oil shows). However, in both the Meged #2 and the David #1 a reservoir quality dolostone was encountered interbedded within the anhydrite and dolomite strata.

The Company contends that the reservoir rock found in Givot Olam's Meged #2 was the result of contemporaneous erosion and deposition of eroding barrier reefs located to the west of Rosh Ha'Ayin[6] during a transgressive cycle (as noted by Korngreen[7] at Asher-Atlit and Givot Olam in its web site). These detrital deposits are expected to be the thickest immediately east of the bounding fault of the basin close to the source as evidenced in the David #1 which is closer to the bounding fault than the Meged #2.

Below ± 6200 meters or ± 20,000 feet in the Asher-Atlit #1, based solely on the analysis of cuttings taken every 10 feet, a gross interval of 219 meters (718 feet) was encountered with light oil shows (35 - 40º API) and with observed porosities ranging from ± 10% to 20%+ with micro fissures. The net interval of this section was calculated to be 78 meters (256 feet) (approximately 1/3 of the interval was volcanic) resulting in a 53% net to gross ratio.

By way of comparison, in the analogous Po Valley of Northern Italy, the Triassic reservoirs produce from carbonates with porosities as low as 3%. The northernmost fields of the internal zone of the Appennine thrust system are the Gaggiano and Villafortuna fields located just south of the intersection of the Apennine system with the Alps. Despite their great depth (4500 - 7000 meters), most of the Triassic reservoirs in the Po Valley are classified as oil. The Gaggiano and Villafortuna fields produce light oil (34 - 42º API) from thrusted Middle Triassic dolomites at depths of 4650-6200 meters. Villafortuna, discovered in 1984, was still in 1999 Italy's most productive oil field (60,000

[6]No reservoir information has been released by Givot Olam for its Mege #3.
[7]Korngreen, I. and Bejamini, Chaim,. 2002, Ben Gurion University, Beersheva

b/d).[8] Conversely, the Malossa field is gas-condensate producing a 52° API condensate with a yield of 155 barrels of stabilized condensate per MMcf.[9]

In the Ash Shaer field of western Syria flow rates of 47 MMcf per day with 3000 barrels of condensate per day have been reported from the Carnian Mulussa formation, which is the Mohilla equivalent.[10]

The Middle Triassic Ladinian (Saharonim) was water wet in the Meged wells and impermeable in the other wells of Northern Israel. The four Ladinian intervals found in the Ma'anit #1 are the first indications that this aged rock could be potentially productive.

Near the base of the Middle Triassic is the Anisian (Gevanim and Ra'af) formation, a thick, slightly porous and fractured carbonate and immediately below it, the Scythian (Zafir) formation, which had light oil shows in Ga'ash #2. The Gevanim is regionally a non-porous carbonate and shale section. The Ra'af is a known reservoir quality rock with mainly secondary porosity in the form of microscopic fractures, styolites, and vugs and observed porosities of 1% to 11%,[11] and has been found oil productive in three of the wells that penetrated it, but it had never been drilled at a location that provides the structure, closure, tectonic stress and proximity to the source beds as is seen Ma'anit. It tested 1200 barrels of water per day ("bwpd") in Deborah #2a, 500 bwpd in Shezaf #1, 210 bwpd in Ga'ash #2, 250 barrels of oil per day ("bopd") in Zuk Tumrur #1 (± 250,000 bbls total) and 20 bopd in Halamish #1 and commingled with the Saharonim, Zafir and Upper Paleozoic produced ± 12,000 barrels of oil in Emunah #1. Test analysis did not determine how much of the flow contribution was from micro fractures and how much from the matrix porosity and permeability.

Seal

The least risk is associated with a seal to the reservoir. Any oil which migrated into a Triassic or older structure should remain, as dense, impermeable limestone and shale comprise the uppermost Triassic and most of the Jurassic.

[8]Holton, Jack, "Four geologic settings dominate oil, gas fields of Italy, Sicily", Oil and Gas Journal, December 1999
[9]Mattavelli, L and Margarucci, V., Structural Traps VII, p 119-137, 1992
[10]From Givot Olam Prospectus
[11]Oil Exploration (Investments) Ltd., 1988, "Hydrocarbon Potential of Israel, Highlights of Basin Analysis".

A3. Ma'anit Borehole Deepening - Report on Jurassic / Triassic section

Biostratigraphic Subdivision using Foraminifera

Part A -report on the Jurassic Interval 2341 - 3310

Introduction and material:

The study of this part was of sieved cuttings from interval 2341 - 3310 m (970 m) at Ma'anit (deepened) borehole. 115 thin sections were made at 8 m intervals of the borehole cuttings. These were examined by petrographic microscope under PPL and documented by Leica DC100. 10 slides were examined under cathodoluminescence to observe features visible only through the diagenetic overprint under the CL, including foraminifera in outline as well some of their internal features. We use an ELM2 CL apparatus mounted on a trinocular Reichert polarizing microscope, with documentation by Photonic Science CCD.

Position of recovery, distribution, and documentation of the key species are shown in Fig. 1 and plate 1.

Foraminifera Occurrence - results

2341 - 2387 m

: *Trocholina* cf. *T. alpina*; *Valvulina lugeoni*; *Nautiloculina oolithica*; *Lenticulina* sp.; *? Orbitammina* sp.; *Epistomina* spp.; *Pseuodocyclammina liasica*; *Ophthalmidium* sp.; *Mesendothyra* sp.; *Tetrataxis* sp.

Trocholina

sp.are much smaller than *T. palaestinensis* and *T. elongata* , and differ from *T. minuta* (Derin & Reiss, 1965) by narrower form but same test height. *T. minuta* s.s. has been observed in strata of late Bathonian and Callovian strata only (Derin & Reiss, 1965, and placed in Bajocian - Oxfordian by Maync, 1966). Absence of proven *Kurnubia* suggests age prior to Callovian. All other foraminifera have long ranges, from the Aalenian upwards.

2387 - 2630 m

: *Pfenderina arabica*; *P. salernitana*; *Amijiella amiji*; *Globuligerina sp.*; *Glomospira* sp.; *Valvulina lugeoni; Nautiloculina oolithica; Ophthalmidium* sp.; *Mesendothyra* sp.; *Epistomina* sp.; *Pseuodocyclammina liasica*;

This interval differs from the above by the absence of *Trocholina* sp. and by upper first appearance (UA) of *Pfenderina* spp. and *Amijiella amiji*.

Pfenderina arabica

ranges from Bajocian - Kimmeridgian, and *P. salernitana* ranges from Bathonian - Callovian. From Callovian upwards they are usually found with *Kurnubia*, which is absent here.

Amijiella amiji

ranges from Sinemurian - Bathonian

The *Pfenderina - Haurania*(= *Amijiella*) subzone defined by Maync, 1964 is placed in the Middle to Upper Bathonian, and appears mainly in northern Israel (Derin, 1966). This interval is therefore considered to be Bathonian in age.

2630 - 2920 m

: *Orbitopsella* sp.fragments; *"Siphovalvulina"* sp.; *Amobaculites* sp.; *Spirillina* sp., *Pfenderina arabica; Valvulina sp.; Nautiloculina oolithica*; *Mesendothyra* sp.; *Epistomina* sp.; *Pseudocyclammina liasica*.

The interval differs from the above by UA of *Orbitopsella* sp. and *"Siphovalvulina"* sp. *Amijiella amiji* appearance here after a lengthy absence indicates it is caved. *Valvulina lugeoni,* which usually appears with *Haurania/Amijiella,* is absent.

Genus *Orbitopsella* sp. is an important guide fossil in Israel to the Middle Liassic, Pliensbachian or Domerian (Derin, 1966; Maync, 1966). The species cannot be determined.

2920 - 3310 m

: Microfossil faunas of this heavily dolomitized part of the sequence are poor and not indicative. Some *Pseudocyclammina* have been found, and some were observed under the CL, which being agglutinated have been known to survive dolomitization,. This is typical for the Lower Liassic section beneath the *Orbitopsella praecursor* zone (Maync, 1966) in northern Israel (In southern Israel this is typically a clastic interval). The underneath interval carry indicative Triassic fossils.

Discussion part A:

The Triassic Jurassic transition in The Lower Liassic sections in northern Israel was effected by extrusive and intrusive magmatism, which has little representation in this borehole. The transition Triassic-Jurassic is taking place at the base of 400 m thick destructive dolomites intercalating with shales section, which is an analog to the thick magmatic section in the north (Asher Volcanics) and to more clastics apearence to the south (Ardon Fm.) The sequence Triassic - Jurassic transition show no lithological disturbance (like Mish'hor Fm.), which might point on the big hiatus known from this part in other places. Only a thin (5 m thick) shally interval appears there with a very pronounced but quit common E log mark.

Part B -report on the Triassic Interval 3310 - 4708

The study of this part was of sieved cuttings too, from interval 3270 - 4708 m at the bottom of the Ma'anit (deepened) borehole. Approximately 350 thin sections were made at 4 m intervals of the borehole cuttings. These were examined by PPL petrographic microscope and documented by same devices as the previous part. 50 slides were polished and examined under the CL.

Position of recovery, distribution, and documentation of the key species are shown in Fig. 2 and plate 1.

Foraminifera Occurrence - results

3310 - 3390 m:

Triasina sp.; *Aulotortus friedli; Glomospira* sp.*; Dustomina* sp.; *Gaudryinella* sp.

Triasina,

although poorly preserved, is common in ooid shoals. The genus is indicative of the Norian - Rhaetian.

The interval is referred to the Norian, Upper Triassic.

3390 - 3855 m:

Aulotortus friedli; Aulotortus sinuosus; Lamelliconus ventroplanus; *L. multispirus*; *Dustomina* sp.; nodosariids.

Lamelliconus

multispirus ranges from upper Ladinian to Rhaetian (Zaninetti, 1976).

The interval lacking *Triasina* is referred to the upper Carnian (Ca1 foraminifera assemblage), Upper Triassic.

3855 - 3955 m

: *Lamelliconus cordevolicus*; *Aulotortus friedli; A. sinuosus, Permodiscus eomesozoicus; L. multispirus; nodosariids.*

Lamelliconus cordevolicus

is a late Ladinian indicator (Zaninetti, 1976).

Permodiscus eomesozoicus

appears in middle Anisian (Zaninetti, 1976), but Benjamini (1988) found it in the Negev in the late Anisian - Ladinian.

The interval referred to the lower part of the Longobardian (late Ladinian) (La2 foraminifera assemblage), Middle Triassic.

3955 - 4160 m:

Glomospirella triphonensis; Lamelliconus cordevolicus; *L. multispirus*; *A. sinuosus*; nodosariids.

Glomospirella triphonensis

appears in the late Scythian - Anisian (Zaninetti, 1976), but Benjamini (1988) extends its appearance to the Ladinian.

Assuming the *Lamelliconus* species are caved, this interval is best referred to the lower Ladinian (Fassanian) (La3 foraminifera assemblage), Middle Triassic.

4160 - 4270 m

: Glomospira negevi; Meandrospira dinarica (fragment); Agathammina austroalpina; *A. sinuosus.*

The *Glomospira negevi* are local forms related to *Pilammina densa* (Benjamini, 1984). The range of *Aulotortus sinuosus* is Ladinian - Norian (Zaninetti, 1976 and others), although its earlier appearance has been reported. We attribute its appearance here most probably to caving.

The interval is referred to the upper Anisian, Pelsonian (An1 foraminifera assemblage), Middle Triassic.

4270 - 4400? m

: *Meandrospira pusilla*; *Gandinella silensis*; *A. austroalpina*; *Plla. Densa; P. semiplana*; *Plla. gemerica*; *A. sinuosus (caved)?.*

Meandrospira pusilla

occurs from latest Scythian through the Anisian (Salaj et al., 1983).

Gandinella silensis

especially in association with *M. pusilla* is referred in the literature to the Lower Triassic (Rettori, 1995; Dager, 1978; Salaj et al., 1983), but the local range of *M. pusilla* and the association with *P. densa*, *Plla. semiplana*, and *Plla. gemerica* places the interval in the upper Anisian.

The *Pilammina densa* range is Pelsonian -Illyrian (Salaj et al. 1983).

The *Pilamminella gemerica* range is Ladinian (Zaninetti, 1976) or Ladinian- early Carnian (Salaj et al., 1983). This discrepancy might be due to caving, but the species was not found in higher intervals, e.g. the Ladinian part of the section.

The interval referred to the upper Anisian, lower Pelsonian (An2 foraminifera assemblage), Middle Triassic.

4400 - 4560 m

: Some caved foraminifera, no appearances of new species, might be ghosts of *Agathammina* sp. cf sp, 1(Benjamini, 1984). Referral of this interval to lower Anisian (An3 foraminifera assemblage) is probable but unconfirmed.

4560 - 4708 m:

Barren of indicative foraminifera; some algal facies. Probably Scythian (Lower Triassic?

Discussion part B:

The biostratigraphy of the Triassic using this type of data is never straightforward. Foraminifera are severely diagenetically altered and poorly preserved, caving is frequent. No conclusively Scythian fauna was found. In general, the only good evidence for the Scythian (Olenekian) in Israel was based on conodonts (Hirsch & Gerry, 1974; Hirsch, 1975, 1998) ostracods (Gerry & Oertli, 1967; Gerry & Derin, 1981), and palynomorphs (Eshet, 1983). However, absence of Anisian forms where appropriate lithologies are present, and underlying confirmed Anisian, has been shown to be a not unreasonable criteria in the absence of conodont of palynological data..

The foraminiferal assemblages of the lower part of the interval referred to the Anisian, above the barren interval which might be Lower Triassic, is characterized by dominance of short-lived

Glomospira-Glomospirella assemblages, including key foraminifers as *P. Densa*; *G. negevi; Glla. triphonensis; G. silensis* and *M. pusilla*. The Anisian interval is further subdivided using these species.

Ladinian assemblages are dominated by aragonitic forms belonging to *Lamelliconus* and *Aulotortus*, including the key species *L. multispirus, L. cordevolicus*, *A. sinuosus* and *A. friedli.*

The Carnian is identified by co-appearance of *A. friedli* and *A. sinuosus* above the uppermost appearance (UA) of *L. cordevolicus.*

The Norian is identified by presence of *Triasina* sp.*,* and assuming that as elsewhere in Israel the Rhaetian is eroded.

The Ma'anit borehole apparently is lacking the lower part of the Carnian, including the Ca2 and Ca3 assemblages (Korngreen, 2004). In addition, Carnian strata are much thinner then in Devora, Ramalla, and Negev sections and more similar to the Carnian part of the Gaash borehole. The Carnian in the Gaash borehole directly overlies upper Anisian strata, while at Ma'anit the Carnian overlies Ladinian strata. Therefore it appears that a hiatus occurs in a similar position, but reduced in temporal extent, at Ma'anit.

Summary

- The top of the studied section 2341 - 2370 m related to Middle Jurassic, Dogger, Upper Bathonian.
- The interval 2370 - 2630 related m to Middle Jurassic, Upper Lias - Dogger, Bajocian - Bathonian.
- The interval 2630 - 2900 m related to Lower Jurassic, Lias, Pleinsbachian.
- The interval 2900 - 3310 m related to Lower Jurassic.
- The top of the Triassic section in the Ma'anit borehole according to foraminifera is approximately at 3310 meters depth, with Norian strata.
- The top of the Carnian is at depth 3390 meters.
- The Ladinian top is at 3855 meters. There is evidence for a hiatus in which parts of the Ladinian and lower Carnian are absent.
- The top of the Anisian is at 4160 meters.
- Lower Triassic is assumed to be present from depth 4500. Other stratigraphic methods have potential to better define the Lower Triassic (conodonts, ostracods and palynomorphs biostratigraphy).

Part C - Preliminary Assessment of Depositional Environments

On the basis of the thin sections prepared for the foraminifera analysis we have made an initial assessment of the main facial subdivisions found in this borehole. [For full analysis including sequence stratigraphy and sequence boundary identification (facies shifts; subaerial exposure), parasequences and cyclicity identification, and correlation with similar features in other boreholes, a further project requiring more thin sections, more CL work, and especially more time, will be required.]

Fig. 3 shows division of the borehole into biostratigraphic intervals as based on the foraminiferal investigation of this report (columns 1-3). Main biogenic and sedimentological components are shown, including dolomite and main diagenetic features, and intercalated volcanics/intrusives, are shown in part 4. Part 5 shows the main facial subdivisions as interpreted in reference to a standard model for carbonate deposition in the Triassic, as in Korngreen and Benjamini (2001). Shallowing is to the right, deepening is to the left, and position of the shelf-edge sedimentary break is usually around zone 4, with

zone 3 characterizing outer neritic, deep shelf open marine environment which is the deepest environment represented.

In part 5, 6 main groups of facies units are distinguished. They are shifted relative to each other by their main facies characteristics. They are presented here from top downwards:

--Group 1 (Middle Jurassic) is dominated by deep shelf environments, and no nearshore or intertidal facies are found.

--Group 2 (Norian to Middle Jurassic) is dominated by dolomitic mosaics which obscure facies interpretation. There are also intervals of volcanic/intrustive intercalations, which may play a significant role in diagenesis. Initial CL work allowed determination of some foraminifera and identification of some exposure related cements, but a complete study of this interval is well beyond the scope of this project. Probably more than one facies unit is represented.

In general there are no off-shelf sediments. The most distal facies represented includes rounded bioclasts, oolites and reef components. Most of the sediments are inner-shelf, lagoonal and tidal features. The dominating dolomitization may therefore be syngenetic or volcanism-related, but consistent with the nearshore shallow restricted environment.

-- Group 3 (Carnian to basal Norian) is highly variable and indicates an apparent increase in amplitude of fluctuations and subsequently in facies position (this feature has been observed in other boreholes). The deepest facies is outer shelf neritic with echinid and filamentous wackestones, passing shoreward via energetic facies with oolites and bioclastic limestones, to algal laminites, peloidal and intraclastal limestones of the lagoonal facies. The amplitude of changes confined to a small part of the section suggests changes in subsidence and accommodation rates, and not necessarily relative sea level change.

-- Group 4 (Ladinian -Carnian) - Apparently a fairly deep part of the section; primarily fossiliferous wackestones with a single event of grainstones; mostly distal neritic.

-- Group 5 (Anisian - Ladinian) - Dramatic shift to shallow water facies, apparently with many events of subaerial exposure. Dominant facies are shelf grainstones to lagoonal mudstones with algal laminites, dolomite but no evaporates.

-- Group 6 (Lower Triassic) - Dominant facies is lagoonal to evaporitic. Ooid grainstones are rare. Mudstones contain anhydrite ghosts, whiskers, and occasionally preserved crystals indicate Salinas or sabhas (indeterminate at this stage).

It is significant that this is the only Lower Triassic evaporite occurrence which we have encountered to date in Israel.

References

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Benjamini, C. 1984. Foraminifera from the Ra'af Formation (Anisian), Har 'Arief, Western Negev, Israel. Benthos 83. 2nd Int. Symp. Benthic Foraminifera (Pau, April, 1983), 35-40.

Benjamini, C. 1988. Triassic foraminifera from Makhtesh Ramon, Central Negev, Southern Israel. Revue de Paleobiologie, Spec. 2:129-144.

Dager, Z. 1978. Triassic foraminifera of the Kocaeli Peninsula, Turkey. Notes du Laboratoire de Paleontologie de l'Universite de Geneve. Fascicule 3/1-4: 23-71.

Derin, B. 1966. A tentative biostratigraphic correlation of Jurassic formations. (unpub.) Isr. Ins. Petr. Rep. 1/66, 16 pp.

Derin, B. & Reiss, Z. 1965. Note on some Jurassic and early Cretaceous *Trocholina* (Foraminiferida) from Israel. (Unpub.) rep. OS/1/65, 11 pp.

Eshet, Y. 1983. Palynostratigraphy, thermal alteration index and kerogen analysis of the Permo-Triassic succession in Makhtesh Katan 2 well. Geol. Surv. Isr. Rep. S/12/83, 171 pp.

Gerry, E., Oertli, J.H. 1967. Bisulcocypris? triassica n. sp. (Crust., Ostrac.) from Israel. Centre de Recherches de Pau (Societe Nationale des Petroles d'Aquitaine). 375-380.

Gerry E. & Derin, B. 1981. Late Permian - Late Triassic in Israel and its significance to oil exploration. In: Israel Geol. Soc. Symposium on Oil Exploration in Israel 2-3 December 1981. p. 9-11.(Abstract).

Hirsch, F. 1975. Lower Triassic conodonts from Israel. Geol. Surv. Isr. Bull. 66: 39-44.

Hirsch, F.1998. The Triassic conodont zonation across the Dead-Sea Rift. GSI Current Research, 11:62-64.

Hirsch, F., Gerry, E. 1974. Conodont and ostracode biostratigraphy of the Triassic in Israel. In: Zapfe, H. ed. Die Stratigraphie der alpine-mediterrane Trias. Symp. Wien. Schriftenre. Erdwiss. Komm. Oesterr. Akad. Wiss., 2:107-114.

Korngreen, D. 2004. The Triassic in Northern Israel. PhD Thesis, in Ben Gurion University of the Negev, Israel (in Hebrew, English abstr.). 132 pp.

Korngreeen, D. & Benjamini C. 2001. Upper Triassic reef facies in the Asher-Atlit1 borehole, Northern Israel: microfacies, cement stratigraphy and paleogeographic implications. Facies, 45, 1-24 p.

Rettori, R. 1995. Foraminiferi del Trias inferior e medio della tetide: Revisione tassonomica, stratigrafia ed interpretazine filogenetica. Universite de Geneve. Departement de geologie et Paleontologie. 147 pp.

Maync, W. 1966. Microbiostratigraphy of the Jurassic of Israel. G.S.I Bull. 40, Rep. 1007, 55 p.

Salaj, J., Borza, K., Samuel, O. 1983. Triassic Foraminifers of the west Carpathians. 213 pp., 156 Pl., Bratislava.

Zaninetti, L. 1976. Les foraminiferes du Trias, Essai de synthese et correlation entre les domains mesogeens europ??en et asiatique. Rivista Italiana di Paleontologia e Stratigrafia 82:1-158.

Figure 3

Figure 3 (continued)

Figure A1. Seismic Coverage Map

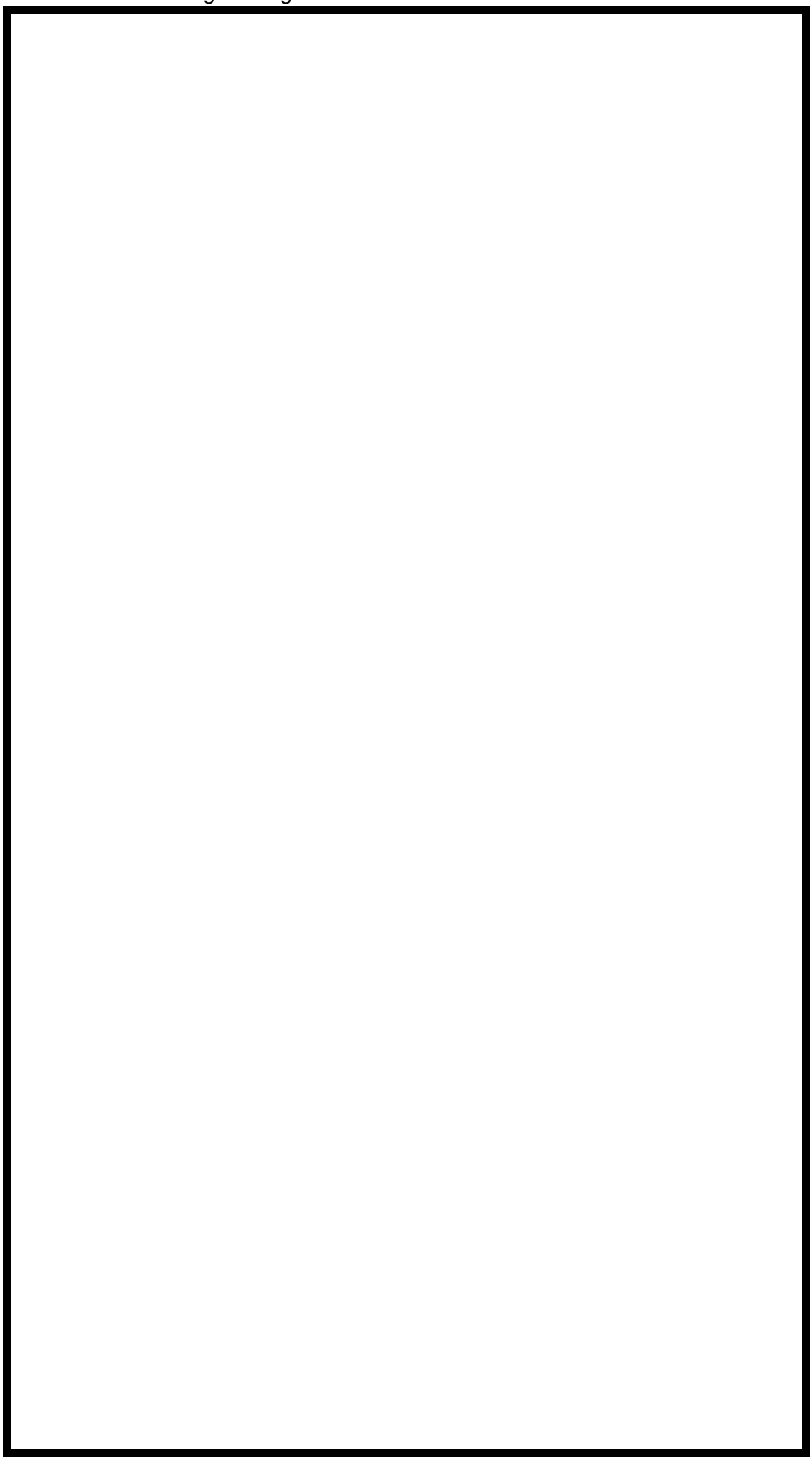

Figure A2. Possible Basement - Depth Map

Figure A3. Paleozoic Marker - Depth Map

Figure A4. Top Triassic at Ma'anit - Depth Map

Figure A5. Top Jurassic - Depth Map

Figure A6. Judea Group - Depth Map

39