

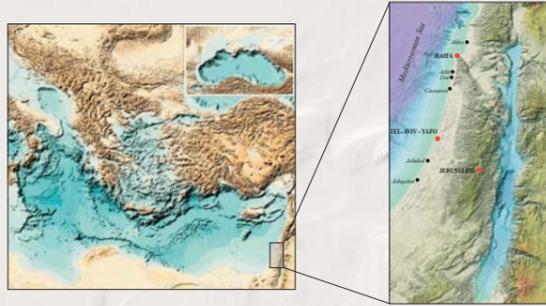


# The Holocene Sea-level of the Coast of Israel

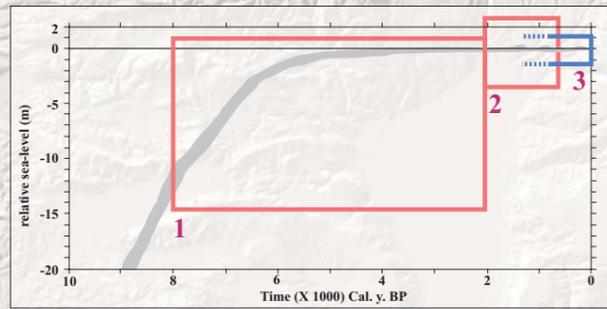
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Location map by Prof. J.K. Hall, Geological Survey of Israel



The Holocene sea-level curve of the Mediterranean coast of Israel is a result of 3 research stages. For most of the Holocene up to 2,000 years ago, and from the 1st century AD up to the 13th century AD, the curve is based mainly on land and underwater archaeological data (→). The observational limits are compared with the glacio-hydro-isostatic models across the region. For the last 1,000 years we use bio-constructions (←).

## Land and underwater archaeological data such as:



The Pre-Pottery Neolithic submerged site of Atlit Yam: The top of the well is at present at a water depth of -10m, and its bottom is at -15.5m.

Photograph by Dr. E. Galili.



Ma'agan Michael shipwreck dated to about 2400 BP.



Man-made rock-cut pool, Shiqmona, south of Haifa.



Caesarea: the archaeological site and the remains of the sunken harbour. Ancient Caesarea was built by King Herod of Judea between 22 and 10 BC.



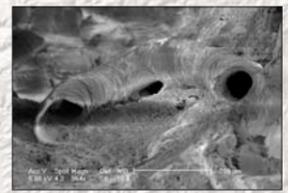
A domestic well excavated in the inner harbour of Caesarea.



Abrasion platforms along the rocky coast of Israel. Cores were drilled in the Vermetid reef, using a pneumatic corer.



A core composed mainly of *Dendropoma* reef unconformably overlying the sandstone substrate. The base of the *Dendropoma* reef is assumed to be an indicator of sea-level.



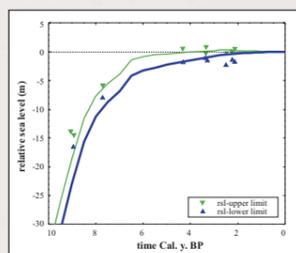
SEM magnification of *Dendropoma petraeum*.

Photograph by Dr. D. Sivan at the University of Aix-Marseille, France

## Bio-construction as sea-level indicator:

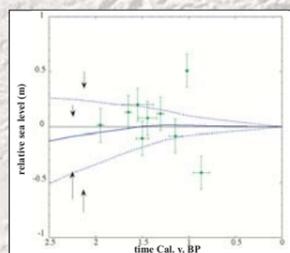
## The results of the three research stages:

### 1. From 9,500 y BP to 2,000 y BP (Early Roman period)



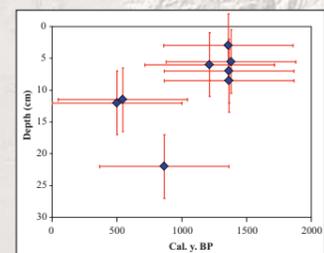
The comparison indicates that at about 9,500 to 9,000 years BP sea-level was not higher than -16.5m, and probably about -20m, or lower. By 8,000 years BP, sea-level had risen, but was still not higher than about -7m, and was probably about -10m, or lower. According to the model predictions, sea-level was still lower than -3 to -4.5m 6,000 years BP, and remained below its present level until about 3,000 to 2,000 years BP.

### 2. From 2,000 y BP to about 700 y BP (end of the Crusader period)



The Caesarea results indicate that about 2,000 years BP sea-level was at its present elevation, while during the Byzantine period it was at or above its present level (about 30cm ±15cm). During the Crusader period sea-level may have been lower than today by about 40cm ±15cm.

### 3. The last Millennium



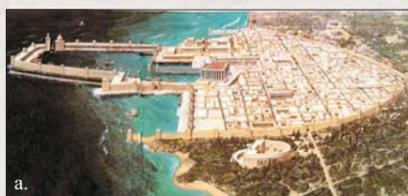
The *Dendropoma petraeum* reef along the abrasion platform, is the tool for reconstructing palaeo-sea-levels for the last 1,000 years. Unfortunately, both the elevation accuracy (±10 to 20cm) and the range of the corrected and calibrated radiocarbon dates obtained from *Dendropoma* do not provide high-resolution data for the rising sea. It seems that sea-level rose slowly from the relatively low levels of the Crusader period to the present level by the 19th century.

## Conclusions:

a. Sea-level reached its present elevation (± 10-15cm) at about 2,000 y BP, while during the Byzantine period it was at or above the present level (about ±30cm). During the Crusader period sea-level may have been lower than today by about ±40cm.

b. The tectonic factor along the coast of Israel has been negligible for the last 9,500 years.

c. Sea-level has been lower by about ± 30cm than the present level since about 700 y ago, stayed lower for few hundred years, and rose by about 20-25cm during the 20th century



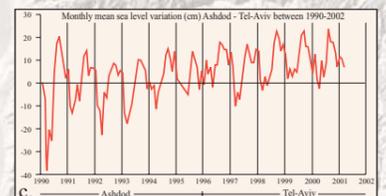
a. A proposed reconstruction of Caesarea during the first few centuries AD.



The north-south aqueduct bringing water to Caesarea, dated to the first few centuries AD, strengthens our conclusion of absence of vertical tectonic movements over the last 2,000 years.



Mediterranean tide-gauge data obtained from 134 stations indicate that average sea-level rise for the last 100 years ranges between 1.0 and 1.5mm/y (10-15cm).



High resolution data obtained by measurements along the coast of Israel show a sea-level rise of 10cm at Ashdod and Tel Aviv stations between 1990 and 2000. This is in addition to a 5cm rise between 1977 and 1991, which means a 25cm rise over 25 years.