ACTIVE FAULTS IN THE COASTAL ZONE OF ISRAEL

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Abstract

Historical reports describe fatal earthquakes that hit the coastal cities of the southern Levant and many of these tremors are not linked to the Dead Sea rift. Geological and archaeological evidence for these earthquakes are ambiguous, because the coastal plain has been cultivated for millennia, and it is difficult to differentiate between products of active faulting and artifacts. High-resolution seismic surveys in the shallow continental shelf show evidence for small faults that offset Pleistocene calcareous sandstone. Off Caesarea, central Israel, geophysical data show a fault that displaces Herodian breakwaters, setting the age of neotectonic activity to less than 2,000 years.

Key-words: continental shelf, tectonics, Levantine Sea

Introduction

Historical documents, some dating back 2,500 years, repeatedly describe catastrophic earthquakes and tsunamis (Appendix I) that inflicted fatal casualties and heavy damages to the coastal cities of the southern Levant (1-6). Any attempt to estimate the real number of casualties and the true rate of damage of a natural disaster from surviving literary accounts should be carried out with great caution. Ancient writers commonly used stock phrases and descriptions in their accounts of the events. In the absence of other information, however, such texts are useful, but should never be considered definitive. Archaeological data, when available, can provide more reliable indicators, especially where they confirm historic documentation. Bearing these reservations in mind, it seems that numerous tremors affected the coasts of the southern Levant in historic times, in addition to the earthquakes that hit the Dead Sea Rift and its environs. The historic records also report on damages caused by tsunamis, but the tectonic significance of such damages undoubtedly ambiguous, because the tsunamis could have originated either along the Levant margin, or in the Anatolian or Hellenic margins.

Geological setting

The present research tried to find out whether the historical records could be supported by geophysical data. The coastal plain of the southern Levant has been cultivated for millennia, and most straight lineament in the rocks there are suspect of being artifacts (7). Therefore we searched for lineaments and elongated cliffs in submarine outcrops of Pleistocene calcareous sandstone in the proximal continental shelf. Indeed, indications for neotectonic activity have already been encountered along the shallow continental shelf of central Israel, off Caesarea and off Atlit, and other sites are yet to be explored. Series of small escarpments, attributed to faulting, were encountered in both places, trending predominantly N-S, and downthrowing their western flank (Figs. 1, 2). Faults of this series occur also along rocky segments of the shoreline in places. Additional faults, trending NE-SW were encountered off Caesarea, and a series trending NW-SE was traced off Atlit. These findings suggest the local characteristic of the NW and NE trending faults, and the regional distinction o the N-S trending ones. Most faults are associated with straight and elongated escarpments, so that they can be considered neotectonic, and had the escarpments been arcuate, a geotechnical process, such as slump or landslide, would have been suggested (6, 8). Since all the faults discerned in the shallow continental shelf offset calcareous sandstone of Pleistocene age, they can be considered active. However, most of the N-S trending faults seemed to outcrop at the sea-floor, whereas many of the NW trending faults seem covered by sediments, and their Holocene activity is dubious.

Complex series of archaeological, geological, and geophysical data

pertaining faulting and earthquakes was encountered off Caesarea. The ancient harbor of Caesarea presents apparently ambivalent structural evidence for neotectonic activity. Caesarea was built in 20-10 BC by King Herod the Great, who named the new city after his mentor, Augustus. The city was built from scratch, and was famous for its outstanding civic installations, such its sophisticated water supply system, its harbor, which was second only to that of Alexandria, and its theater, stadium, temple, and other amenities required in a Roman metropolis. The large Herodian breakwaters , which extended some 400 m seawards, are presently submerged 5-8 m below sealevel, whereas other contemporary coastal and harbor installations remain at sealevel. The submerged marine constructions prompted some to suggest faulting along the coast in Caesarea (9, 10), while the stability of coastal constructions led others to suggest structural stability (11, 12).

In the course of the present study, high resolution seismic reflection profiles were carried out in the shallow continental shelf. These profiles encountered a series of coast-parallel faults that displace both the Pleistocene calcareous sandstone, which crops out along the coastal zone, as well as the submerged Herodian breakwaters. The faults show

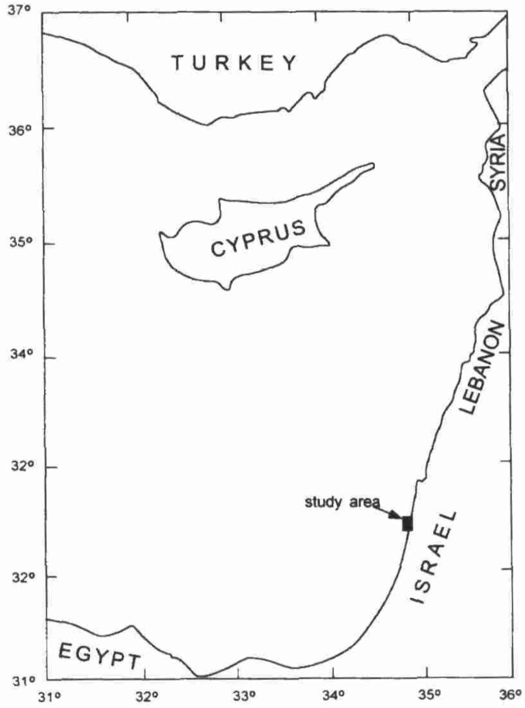

Fig. 1. The eastern Mediterranean and the study area.

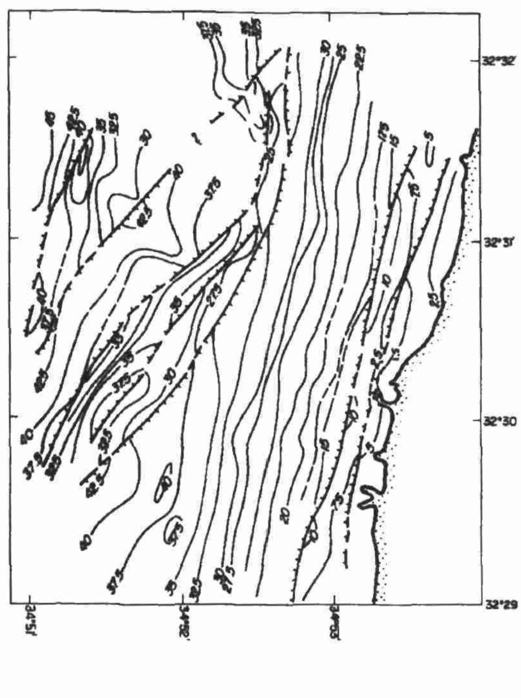

Fig. 2. Structural map of the upper surface of the Late Pleistocene calcareous sandstone off Caesarea in central Israel. See Fig. 1 for location.