DESTRUCTION OF OLYMPIA'S ANCIENT HARBOUR SITE BY A TSUNAMI IMPACT

A. Vött [1]*, G. Bareth [1], H. Brückner [2], I. Fountoulis [3], F. Lang [4] and D. Sakellariou [5]
[1] Institute for Geography, Universität zu Köln - andreas.voett@uni-koeln.de
[2] Faculty of Geography, Philipps-Universität Marburg
[3] Department of Dynamic, Tectonic, Applied Geology, National and Kapodistrian University of Athens
[4] Department of Classical Archaeology, Technische Universität Darmstadt
[5] Hellenic Center for Marine Research

Abstract

This paper presents geo-scientific characteristics of a beachrock-type calcarenitic tsunamite from the Bay of Aghios Andreas (Peloponnese, Greece). Geomorphological, sedimentological, micromorphological, geochemical and geochronological studies were conducted to clarify the depositional processes and the post-sedimentary evolution. We found sedimentary structures such as basal unconformities, rip-up and intra-clasts, evidence of fining upward, thinning landward and upward increase in sorting as well as bi-to multimodal deposits all of which are described as features typical of recent or historic tsunami deposits. It is concluded that in the Bay of Aghios Andreas, Olympia's ancient harbour site was destroyed by tsunami impact.

Keywords: Beach, Coastal Processes, Eastern Mediterranean, Geomorphology, Sea Level

Tsunami hazard in the eastern Mediterranean is among the highest worldwide. This is mostly due to the high seismic activity along the Hellenic Arc where the African Plate is being subducted under the Eurasian Plate inducing numerous strong tsunamigenic earthquakes. In addition, the Arabian Plate, moving northward at fast rates, is a serious source of seismically-related hazards. Paleotsunami research in the eastern Mediterranean has been strongly intensified during the past decades, in order to improve our understanding of the dimension and the dynamics of tsunami landfalls, and to gain reliable background information for future risk assessment. In addition to archival studies based on ancient accounts and historical data, an increasing number of geo-scientific field studies have been carried out to detect palaeotsunami deposits.

A new type of event deposit, beachrock-type calcarenitic tsunamites, has been described for the first time, based on three case studies from western Greece ([1], [2]). Here, we present details from beachrock studies at ancient Pheia, the harbour site of Olympia, which is located in the Bay of Aghios Andreas in the western Peloponnese. The archaeological remains of Pheia are almost completely submerged and lie in water depths down to 5 m below present sea level. The harbor is said to have been destroyed by earthquakes in the 6th century AD, most probably in 521 AD and/or 551 AD ([3]). The modern beach of Aghios Andreas is characterized by thick beachrock layers. In former studies, this beachrock was used as sea level indicator thus explaining the submergence of ancient Pheia by a complex sequence of gradual subsidence (6.5 m) and following minor uplift (1.5 m, [4]).

We carried out geomorphological, sedimentological, geoarchaeological and geochronological studies. The basal section of the beachrock, up to 3 m thick, is lying on top of an erosional discordance and consists of abundant coarse gravel. The mid-section of the beachrock is clearly laminated and shows several fining upward sequences out of fine sand from the littoral zone. Further sedimentary structures found are convolute bedding and load casting, both untypical of littoral environments. Such characteristics rather indicate gravity-induced flow dynamics in a water-saturated suspension-like matrix. In some areas, large ashlars were found incorporated into the calcarenite. These man-made blocks, still angular, do not show any signs of being moved or altered in the littoral zone; one block is even coated with original white plaster. Moreover, vibracoring revealed clear thinning land- and sideward of the beachrock, and the beachrock was discovered up to 40 m distant from the coast and up to 2.60 m above present sea level. It is, however, known from previous studies that during the Holocene, the relative sea level in the area has never been higher than at present ([3], [5], [6]).

Based on our results, the beachrock sequence at Aghios Andreas does not reflect at all sedimentary characteristics typical of a (lithified) beach but rather represents high-energy event deposits. Convolute bedding and load cast structures are assumed to document intermittent backflow shortly after high-energy deposition of thick allochthonous sand deposits onshore. We thus suggest that Olympia's harbor site was hit by tsunami associated to strong earthquakes. Submergence of Pheia's archaeological remains seems to be of co-seismic nature such as observed during the southeast Asia tsunami in 2004.

References

1 - Vött A. and May S.M., 2009. Auf den Spuren von Tsunamis im östlichen Mittelmeer. *Geogr. Runds*., 12: 42-48 (in press).

2 - Vött A., Bareth G., Brückner H., Curdt C., Fountoulis I., Grapmayer R., Hadler H., Hoffmeister D., Klasen N., Lang F., Masberg P., May S.M., Ntageretzis K., Sakellariou D., Willershäuser T., 2010. Beachrock-type calcarenitic tsunamites along the shores of the eastern Ionian Sea (western Greece) – case studies from Akarnania, the Ionian Islands and the western Peloponnese. Z. f. *Geomorphol*. N.F., Suppl. Vol. (in press).

3 - Kraft J.C., Rapp G. (Rip), Gifford J.A. and Aschenbrenner S.E., 2005. Coastal change and archaeological settings in Elis. Hesperia, 74/I: 1-39.

4 - Fouache E. and Dalongeville R., 1998. Neotectonics in historical times: the example of the Bay of Aghios Andreas (Ilia, Greece). Z. f. *Geomorphol*. N.F., 42/3: 367-372.

5 - Vött A., 2007. Relative sea level changes and regional tectonic evolution of seven coastal areas in NW Greece since the mid-Holocene. *Quat. Sc. Rev*., 26: 894-919.

6 - Engel M., Knipping M., Brückner H., Kiderlen M. and Kraft J.C., 2009. Reconstructing middle to late Holocene palaeogeographies of the lower Messenian plain (southwestern Peloponnese, Greece): Coastline migration, vegetation history, and sea level change. *Palaeogeogr., Palaeoclimatol., Palaeoecol*., doi: 10.1016/j.palaeo.2009.10.005.