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Holocene environmental change at the oasis of Tayma

Max Engel (1), Helmut Brückner (1), Kai Wellbrock (2), Anna Pint (1), Matthias Grottker (2), Peter Voss (2), Andreas Ginau (3), Nicole Klasen (1), and Peter Frenzel (4)

(1) University of Cologne, Geographical Institute, Department of Geoscience, Köln, Germany (mengel2@uni-koeln.de), (2) University of Applied Sciences Lübeck, Laboratory of Urban Water and Waste Management, Lübeck, Germany, (3) University of Frankfurt/Main, Geographical Institute, Frankfurt, Germany, (4) University of Jena, Department of Earth Science, Germany

The oasis of Tayma in northwestern Saudi Arabia has a rich cultural heritage comprising a large number of historic buildings and artefacts from the late Neolithic onwards. Extensive groundwater resources and the location at a branch of the Incense Road connecting south Arabia and the eastern Mediterranean determined the site's importance in Antiquity. This paper reports about Holocene environmental change at Tayma setting the frame for the interpretation of the archaeological record.

Humid conditions during the early Holocene are inferred for the Arabian Peninsula (AP) based on the investigation of sabkhas, palaeo-lakes, sand dunes, wadis, speleothems and marine sediments. Most of these climate archives are located in the southern and southeastern part of the AP, where a northward shift of the Intertropical Convergence Zone (ITCZ) triggered increased rainfall at the onset of the Holocene. At Tayma, where the influence of the ITCZ shift can be excluded, the sedimentary infill of a sabkha basin, the micro- and macrofaunal record, a digital elevation model based on DGPS measurements, and ^{14}C-AMS data indicate the presence of a perennial lake with a minimum depth of 13 m, a stored water volume of 1.16 •10^7 m^3 and a surface of 18.45 km^2 between 10,000-9000 cal BP. Foraminiferal test malformations and the shape of sieve pores on ostracod valves were used to detect trends in palaeo-salinity and ecological stress conditions. Contraction of the lake at least after 8500 cal BP is a response to a long-term aridisation trend subsequent to the early Holocene. Based on the hydrological water balance equation, quantitative data on minimum palaeo-rainfall during the early Holocene humid period were determined. Input parameters for the equation are the minimum lake level, lake surface and lake volume during the peak of the early Holocene humid period as well as palaeo-evapotranspiration, groundwater infiltration, and surface runoff. A perennial lake in the endorheic basin of the modern sabkha with a lake level at the same elevation as the uppermost shoreline deposit would have required a minimum annual precipitation of 150 +/- 25 mm (three times the modern value).