Aquatic environments of the early to mid-Holocene humid period (EHHP) on the Arabian Peninsula – Update from DFG Project CLEAR

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Introduction

An early to mid-Holocene humid period (EHHP) has been identified for the Arabian Peninsula (AP) based on sedimentary archives (Fig. 1) (e.g. Parker et al., 2006; Engel et al., 2012; Matter et al., 2016) and speleothem data (e.g. Neff et al., 2012). Recent climate models (Fig. 2) identify an increased eastward migration of the East African monsoon as the source of the precipitation surplus (Jennings et al., 2015; Guagnin et al., 2015). Whether up to three times and more the amount of today’s annual precipitation (Fig. 2) in combination with charged aquifers led to the formation of substantial lakes or spatially limited wetlands is a matter of recent debate (Engel et al., 2015, 2017; Engell et al., 2017).

Aims & results

Project CLEAR aims at reconstructing climatic and landscape changes on the AP during the EHHP based on sediment-based multiproxy evidence from an endorheic basin at the oasis of Tayma, and how these changes controlled settlement and cultural dynamics at the oasis (https://clear2018.wordpress.com). This paper presents morpho-sedimentary (=remnant shorelines) and macrofossil evidence for a perennial lake during the EHHP from the sabkha basin north of the oasis. Shoreline index points include:

• in-situ Amphibolites amphibole, a barnacle of marginal marine habitats, either attached to bedrock (Figs. 5, 11) or to parautochthonous bedrock clasts (Fig. 4);
• in-situ or parautochthonous sequences of shell detritus from A. amphitrite (Fig. 1a), gastropods (Melanooides tuberculatus, Hydrobia sp.), marginal marine foraminifers (Fig. 11), the brackish water ostracod Cypreis terrosa (Fig. 1b), and quartz sand.

All macrofossil taxa require/tolerate perennial, saline waters (Guagnin et al., 2012; Engel et al., 2012; Pint et al. 2016, revised). Mass occurrences of sessile A. amphitrite represent an outstanding indicator for the long-lasting lake. It was found in living position at various sites around the basin (Figs. 6, 7, 13), and indicates intertidal conditions, warm and turbated water, and high, fluctuating salinities (up to 40–45‰) (Por et al., 1972; Shalla et al., 1995; Dietrich et al., 2002).

Discussion & conclusions

Despite strong episodic erosion and widespread aeolian deposition, a high number of shoreline features are still preserved and assessable at elevations of 808–813 m a.s.l. Based on hardware-corrected (cf. Dinies et al., 2015) 14C data from Tay 11/177 and 180 (Figs. 4, 6, 13), the highest shoreline overprints with the most humid phase of maximum grassland expansion at 8600–8800 cal BP inferred from the palynological (Dinies et al., 2015) and geochemical (Neugebauer et al., 2016) record of sediment cores inside the sabkha basin (Fig. 4). At that time, the lake had a perennial regime, breaching to seasonally hypersaline conditions, a depth of up to 17 m and a min. area of 22 km², thus testifying to the substantial impact the EHHP had on landscapes of the API.

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References

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Fig. 1: Key outcrops sites on the API including the oasis of Tayma (Engel et al., 2017)

Fig. 2: Max. possible rainfall around 8 ka BP as simulated with the COSMOS toolbox (modified after Guagnin et al., 2016).

Fig. 3: Transect (Fig. 4) through oasis and sabkha basin (Figs. 6, 13), and indicates intertidal conditions, warm and turbated water, and high, fluctuating salinities (up to 40–45‰) (Por et al., 1972; Shalla et al., 1995; Dietrich et al., 2002).

Fig. 4: The oasis of Tayma with sediment cores containing lacustrine facies, shoreline sites, and the approximate extent of the early to mid-Holocene palaeo-lake using the local high-resolution DEM of Wellbrock et al. (2010). The white line indicates the transect of Fig. 3.

Fig. 5: Transect (Fig. 4) through oasis and sabkha. The bluish-green layer represents the perennial lake phase correlating with highest Holocene shorelines (Engel et al., 2012).

Fig. 6: a) Bioclastic deposit attached to locally outcropping bedrock, exposed over +10 m and inclining towards the sabkha basin; b) In-situ barnacles attached to bedrock clasts floating in the bioclastic matrix.

Fig. 7: a) View towards a wash channel entering the sabkha basin with DGPS base in the foreground; b) Along both wash-flanks, in-situ barnack colonies are preserved.

TayS15-14: 814.92 m a.s.l.

TayS15-15: 805.12 m a.s.l.

Fig. 13: Shoreline deposit, up to 3 m thick, mainly comprising of barnacles, gastropod shells, four foraminiferal taxa, and Cypreis terrosa (ostracod). In-situ barnacles and 14C data (hardwater effect 1000–1500 yrs., Dinies et al., 2015) indicate deposition between c. 9–7.5 ka cal BP (Engel et al., 2012).