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Assessing long-term habitability at an eastern Sahara oasis: ESR dating of molluscs and herbivore teeth at Dakhleh Oasis, Egypt

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ABSTRACT

In the northeastern Sahara, electron spin resonance (ESR) dating of when animals lived documents their habitability in Dakhleh Oasis, Egypt. A Middle Pleistocene paleolake(s) covered >1700 km^2. At eastern Locality Dak348, 10 m thick, remnant lacustrine marls yielded Pleistocene fauna, rare artefacts, and plant casts. No obvious unconformity exists within these deposits. From upper horizons, a hartebeest tooth ESR dated at 195 ± 11 ka, correlates with Marine Isotope Stage (MIS) 7, while molluscs from a stratigraphically higher horizon averaged 89 ± 10 ka, correlating with MIS 5a/b. At western Locality Dak006, upslope deflation has left a temporally mixed surficial lag. Numerous lagged tooth fragments, independently dated by ESR, correlate with MIS 5 through 17. Fragments from a slope sand unit correlate with MIS stages 3 through 6. One bovid tooth associated with Younger Middle Stone Age artefacts in the base of the sand dated at 84 ± 7 ka (MIS 5a/b). Molluscs from Romano-Byzantine backdirt at a breached artesian vent dated to 8–15 ± 1 ka, suggesting that ponds formed during MIS 1 and 2. Even without well defined sedimentary contexts, ESR frequency data indicate that the oasis was habitable for herbivores during at least twelve stages in the Mid-Late Quaternary, and, therefore, likely also for humans.

1. Introduction

When we address the processes of 'greening' the Sahara during multiple Pleistocene periods, the roles played by long–lasting oases serving as refugia for vegetation and fauna–and humans–should be considered (cf. Larrasoaña, 2012; Smith, 2012; Foley et al., 2013; Larrasoaña et al., 2013). One such oasis is Dakhleh Oasis (also Dakhla or Dakla) in the Egyptian Western Desert, the largest in both modern population and cultivated area (Fig. 1). The administrative center, Mut, lies at 25° 29′ N, 29° 00′ E, ~600 km southwest of Cairo, and ~280 km by road from the Nile Valley at Assiut. In the same physiographic area (Hermina, 1990), the neighboring Kharga Oasis is ~180 km to the east, closer to the Nile Valley. The modern cultivated Dakhleh Oasis and the wider extent of the 'palaeo-oasis' occupy two deflated eastern and western Lowland basins, separated by an eroded sandstone ridge representing the uplifted Tawil Anticline. The bounding steep Escarpment that edges the Libyan Plateau on the north and northeast rises to >400 m above the lowest points in western Dakhleh at ~100 m a.s.l. To the south lies the Dharb el-Arbain (or Nubian) Desert.

The Dakhleh Oasis Project (DOP) has conducted archaeological and environmental research in the oasis region, starting in 1977. DOP is a long-term, multidisciplinary study by archaeologists, earth scientists and other environmentalists (Churcher and Mills, 1999; Hope and Mills, 1999; Marlow and Mills, 2000; Hope and Bowen, 2002; Bowen and Hope, 2003; Thurston, 2003; Wiseman, 2008;

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Bagnall et al., 2012). Evidence for human occupations ranges from that of Pleistocene and Holocene prehistoric times through the Historic Period to Medieval Islamic times, and to the present day (Kleindienst et al., 1999).

Holocene prehistoric cultural units and environmental changes are relatively well dated (McDonald, 2001, 2009). However, few chronometric ages have been reported for Pleistocene deposits; some determinations are as yet unpublished. $^{230}Th/^{234}U$ dates on redeposited tufa blocks and calcretes constrain the ages of some deposits of gravels and eroded lakebeds (Churcher et al., 1999; Kleindienst et al., 1999, 2008). Dakhleh Glass, a melt rock formed when an asteroid exploded in a catastrophic airburst or impact, occurs embedded in or lagged on some Pleistocene lacustrine deposits (Kleindienst et al., 2006; Kieniewicz, 2007; Osinski et al., 2007, 2008; Schwarcz et al., 2008). A limiting date during deposition for these outcrops is provided by $^{39}Ar/^{40}Ar$ ages on the glass averaging 145 ± 19 ka and adjusted to ~146 ka (Renne et al., 2010). Dakhleh region was adversely affected for some time (Smith et al., 2009). Thus, the ESR (electron spin resonance) dates reported herein significantly increase the geochronological database for reconstructing palaeoenvironments.

2. Regional setting

Today, in the hyperarid desert, Dakhleh Oasis life and irrigation agriculture totally depend upon deep boreholes tapping the Nubian Sandstone Aquifer (Ebraheem et al., 2004; Gossel et al., 2004; Kato et al., 2012; Sefelnasr et al., 2014) and some short-lived shallow wells. Annual precipitation approaches nil (Vose et al., 1992), although some heavy or persistent rains have been recorded, most recently in 2008 and 2014. In the Pleistocene, however, surface water was present. Numerous fossil artesian spring vents brought water to the surface from the Nubian Aquifer (Kleindienst et al., 1999; Adelsberger and Smith, 2010), and large lakes and wetlands existed (Churcher et al., 1999; Kleindienst et al., 1999; Kieniewicz, 2007; Kieniewicz and Smith, 2009; Churcher and Kleindienst, n.d.). On the Escarpment face three areas with poorly preserved, spring-deposited tufa terraces were located, and redeposited tufa boulders indicate other areas of deposition. Two terraces were $^{230}Th/^{234}U$ dated to >200 ka. Tufas mark where surface water flowed from the north into the Lowland, as do wadi cuts into the Escarpment. The modern sand sheet and dune belt obscure a large southern catchment area draining into the western basin (Kieniewicz and Smith, 2009). Eroded, terraced remnants belonging to at least three periods of fan/bajada formation below the Escarpment provide additional evidence (Brookes, 1986, 1993; Kleindienst et al., 1999). The P-I, P-II, and P-III (or P/B) geomorphic surfaces (Fig. 2) bear fluvial boulder gravels that extend far south into the central and eastern lowlands, indicating multiple periods of more vigorous precipitation in the past. On the Escarpment face, evidence for slumping, landslides and debris flows reflect times when shales underlying the limestone cap rocks of the Libyan Plateau were saturated. Scattered fossil faunal remains (Churcher, 1999a, 1999b; Churcher et al., 1999; Churcher et al., 2008), and scarce vegetal remains (Thanheiser, 2008) also provide evidence that palaeoenvironmental conditions allowed an African savannah to develop during and after the later Middle Pleistocene.

In the following sections, Localities of archaeological interest and study are indicated by DakXXX. Field Sample numbers (DXXX) refer to pieces collected within the same area; Analyzed Sample numbers (e.g. FTXX, RMXX, etc.) refer to pieces from field samples that were suitable for, and dated by, ESR.

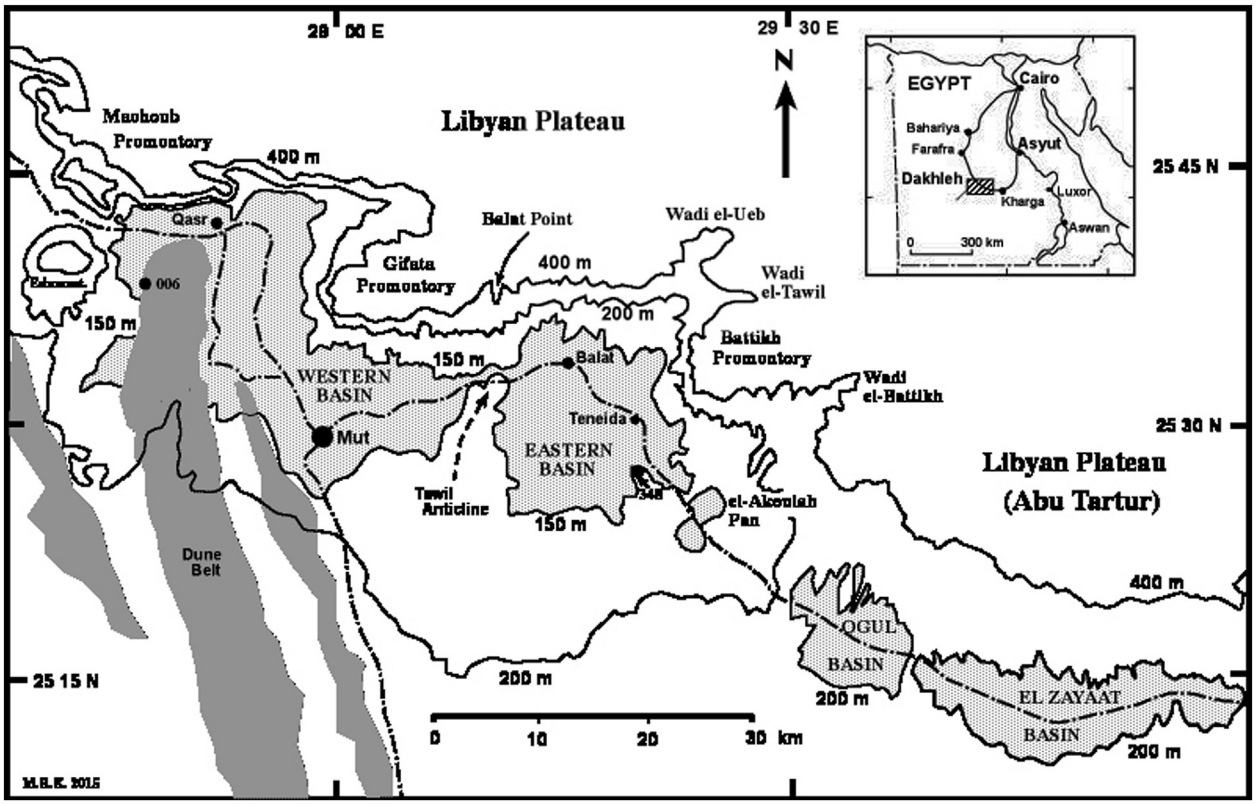

Fig. 1. Dakhleh Oasis Region, Western Desert, Egypt, showing two modern basins (lighter shading) separated by the Tawil Anticline sandstone ridge, and main settlements. Elevations are given in meters above sea level (a.s.l.). The two shallow basins to the east at higher elevations held shallow Late Pleistocene palaeolakes, but have not been thoroughly surveyed for Pleistocene evidence. Dune streak is dark shaded.