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# AN EARLY HOLOCENE TRANSITORY ARID PHASE IN THE CENTRAL SAHARA AT THE TIME OF THE 8.2 KY BP CLIMATE ANOMALY

**Andrea Zerboni**
Dipartimento di Scienze della Terra "A. Desio", Università degli Studi di Milano
*Corresponding author:* A. Zerboni <andrea.zerboni@unimi.it>

ABSTRACT: Zerboni A., *An early Holocene transitory arid phase in the central Sahara at the time of the 8.2 Ky BP climate anomaly.* (IT ISSN 0349-3356, 2011)
The beginning of the Holocene in the Sahara is marked by increased rainfall due to the expansion of the African monsoon over the North Africa. In the central Sahara springs were activated in the mountains and shallow lakes formed between dunes. An isotopic and geochronological approach to the study of spring and lake carbonates allowed defining the beginning of the Holocene humid period; moreover, data show its abrupt interruption at c. 8 Ky BP. The arid spell is attributed to the 8.2 Ky BP event and its significance is discussed in the frame of Holocene climate changes recorded in North Africa and in the Mediterranean.

*RIASSUNTO:* Zerboni A., Una breve fase arida registrata nel Sahara centrale in corrispondenza dell'anomalia climatica di 8.2 Ky BP. (IT ISSN 0349-3356, 2011)
*L'inizio dell'Olocene nel Sahara è marcato da un incremento delle precipitazioni causato dall'espansione dell'area di influenza monsonica sul Nord Africa. Nel Sahara centrale furono attivate sorgenti nelle aree montane e si formarono laghi tra le dune. Lo studio isotopico e geocronologico di carbonati lacustri e di sorgente ha permesso di definire l'inizio della fase umida olocenica e di identificare un evento arido a 8 Ky BP. Tale evento è posto in relazione con l'anomalia climatica di 8.2 Ky BP e il suo significato viene discusso nell'ambito delle variazioni climatiche registrate in Nord Africa e nel bacino del Mediterraneo.*

Key words: climate changes, palaeohydrological records, 8.2 event, African monsoon, Sahara.

*Parole chiave: cambiamenti climatici, archivi paleoidrologici, evento 8.2, monsone africano, Sahara.*

## 1. INTRODUCTION

The palaeoenvironmental research carried out in the hyperarid central Sahara (SW Libya) permitted to elucidate the time and steps of the Holocene climatic changes occurred in the region (CREMASCHI & ZERBONI, 2009). The isotopic and geochronological study of carbonatic sediments related to highly sensitive palaeohydrological archives (CREMASCHI *et al.*, 2010) allowed to date the beginning of humid phase and evidenced the role played by the 8.2 Ky BP climate anomaly.

## 2. METHODS

Spring and lake sediments were discovered and sampled during a geoarchaeological survey. Spring tufa were dated using multicollector ICP-MS techniques (details in FLEITMANN *et al.*, 2007). Organic lake sediments were radiocarbon dated and ages calibrated (2σ) using the INTCAL04 calibration curve (REIMER *et al.*, 2004). The stable C- and O-isotope values were measured using a ThermoFinngan Delta$^{plus}$XI isotope ratio mass spectrometer and results are reported in ‰, relative to the Vienna PeeDee Belemnite (VPDB).

## 3. RESULTS AND DISCUSSION

Tufa formation typically required abundant water and a continuous soil cover in order to account for $CO_2$ input into the groundwater system. According to U-Th data such conditions lasted from 9.6 to 7.6 Ky BP (Fig. 1a). Stable isotopes recorded a trend towards wetter conditions between 9.6 and 8.8 Ky BP, whereas, after a hiatus, less negative $\delta^{18}O$ values suggest a reduction in precipitation (Fig. 1b). A major hydrological change is also evident from the $\delta^{13}C$ versus $\delta^{18}O$ cross plot, differentiated on the basis of U/Th ages: tufa deposited before 9 Ky BP shows $\delta^{18}O$ values ranging from -12 to -9‰, while younger tufa shows values ranging from -9 to -2‰ (Fig. 1c), suggesting higher rain supply to springs and soil metabolism at the beginning of the period, followed by a progressive decline (CREMASCHI *et al.*, 2010). Conditions suitable for tufa formation were substantially reduced c. 8 Ky BP, whereas the occasional persistence of local tufa deposition until c. 7.6 Ky BP may be related to the resilience of water saturation in parts of the mountain.
Carbonatic lake deposits discovered in the sand seas indicates former, large groundwater-fed water bodies, which origin was directly linked to the

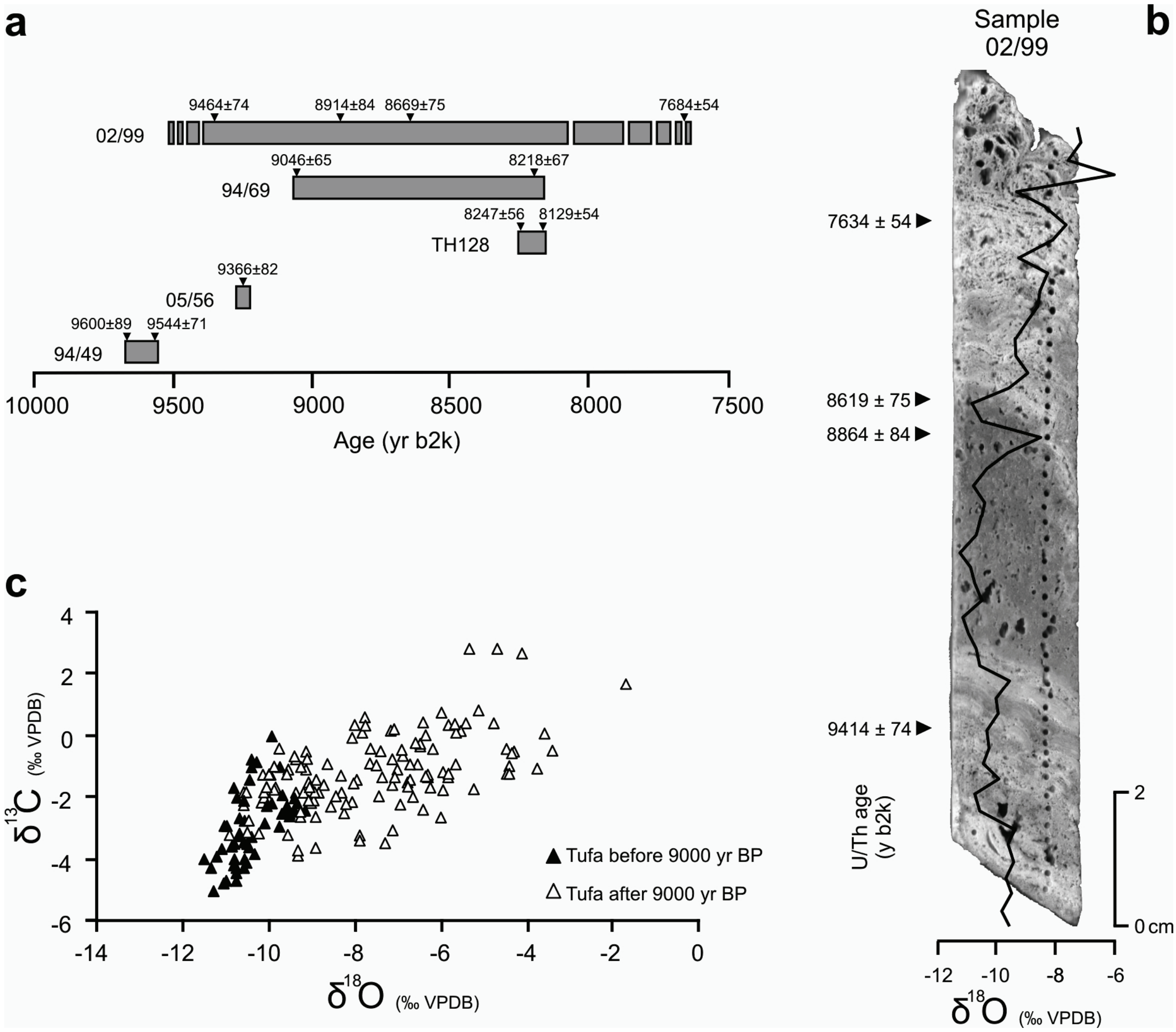


Fig. 1, a) Duration of tufa deposition in each locality. (b) O-isotope profile of sample 02/99. (c) $\delta^{13}$C versus $\delta^{18}$O data differentiated on the base of U/Th ages (from CREMASCHI *et al.*, 2010).
*(a) Durata della deposizione di calcareous tufa in ogni località. (b) Curva isotopica del campione 02/99. (c) Dati isotopici ($\delta^{13}$C versus $\delta^{18}$O) differenziati sulla base delle datazioni U/Th (da CREMASCHI et al., 2010).*

amount of rainfall feeding confined, surface aquifers. More than 70 samples of organic lake sediment have been dated, reflecting Holocene age. Groundwater seepage is recorded from 8.9 to 1.6 uncal. Ky BP, but most of the results are concentrated in the interval 10.5–5.5 cal. Ky BP. Limnic activity is well dated in the edeyen of Murzuq, due to the existence of deep organic to carbonate-rich lacustrine sections; two distinct water high stands were identified, interrupted by an arid phase between c. 8.2 and 7.8 cal. Ky BP.
Hydrological changes recorded in the central Sahara agree well with records of climate changes in the surrounding region (Fig. 2); for instance, a gap in sedimentation and erosion under arid conditions are registered by anthropogenic cave deposits from the Tadrart Acacus massif (CREMASCHI *et al.*, 2010). The attribution of the dry phase recognized in the study area to the 8.2 event is consistent with a palaeoclimatic model proposed by WIERSMA & RENSSEN (2006). An anomaly at 8.2 Ky BP was identified in many proxy records from the African monsoon region (MAYEWSKI *et al.*, 2004). A drop in precipitation was recorded by summer-monsoon-fed lakes between 8.5 and 7.8 cal. Ky BP (Fig. 2) and was reported from several continental records from the circum-Mediterranean region (BERGER & GUILAINE, 2009). Finally, the arid spell was largely coeval with the relapse within sapropel S1 in the Mediterranean Sea, supporting the hypothesis concerning a strong correlation between weakening in the African monsoon intensity and interruption of anoxic events in the Eastern Mediterranean (ROHLING *et al.*, 2002).

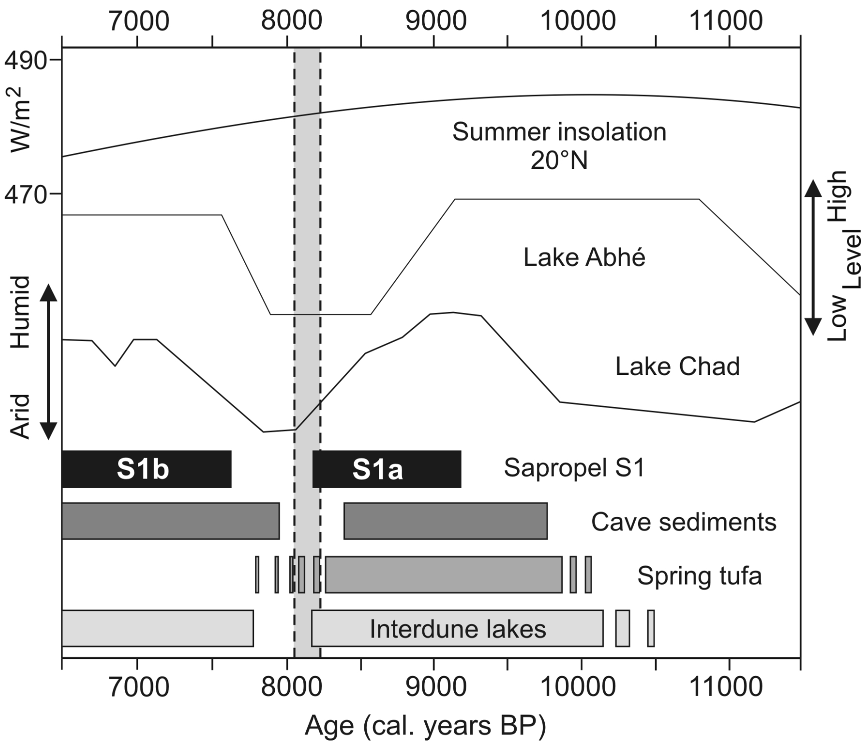


Fig. 2, Palaeohydrological records from the central Sahara compared with other archives from North Africa and the Mediterranean region; the grey bar indicates the 8.2 event (THOMAS *et al.*, 2007).
*Record paleoidrologici centro-sahariani comparati con altri record paleoclimatici dal Nord Africa e dall'area mediterranea; la barra grigia indica l'evento 8.2 (*THOMAS *et al., 2007).*

## 4.CONCLUSION

Deposition of carbonates in today's hyperarid central Sahara records a prolonged period of wet climate which prevailed during the early Holocene in response to a northward expansion of the SW African Monsoon system, controlled by the insolation maximum. The available data suggest a gap in sedimentation between 8.2 and 7.8 Ky BP. Probably triggered by the abrupt drainage of Laurentide lakes and subsequent slowdown of the North Atlantic thermohaline circulation (THOMAS *et al.*, 2007), this event led to a temperature reduction in the Guinea Gulf and a strong decrease in evaporation. As a consequence, the strength of the African monsoon decreased, with the sudden shutdown of water supply to the central Sahara and reduction of runoff to the Mediterranean Sea.

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