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SEARCH FOR PEDOGENIC PHASES DURING THE YOUNGER PLEISTOCENE AND HOLOCENE (SOLTANIEN AND RHARBIEN) OF TUNISIA

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ABSTRACT. Radiocarbon dates, obtained from paleosols, sediments, fossils, and groundwater samples of North Africa and especially, Tunisia, were investigated for information on phases of pedogenesis throughout the younger Pleistocene and Holocene in north and central Tunisia. This paper evaluates available data, while a larger set of new samples is under study, which, hopefully will exhaust the problem and will reveal whether extrapolations such as those made in this paper, eg, phases of pedogenesis from groundwater data, are correct.

Frequency distribution of the dates from groundwaters taken by systematic sampling, as well as from random soil samples from open pits that yielded access to buried paleosols, indicate that organic matter was being produced for 7 or 8 periods. The evidence suggests major pedogenic activity at about 2000 BP, 4000 to 6000 BP, 8000 to 12,000 BP, and perhaps 21,000 to 25,000 BP.

INTRODUCTION

The classic concept of pluvial and interpluvial paleoclimatic phases in the Quaternary of xeric and aridic zones of North Africa has been disputed (Rohdenburg, 1970; Butzer, 1971; Rohdenburg and Sabelberg, 1973; Brunnacker, 1973; 1974; Sabelberg, 1977). Dating of paleosols, charcoal, shells, mollusks, and calcareous crusts imply rather a parallelism in tendency between climatic cycles of African subtropics and temperate European areas. Groundwater dates were also interpreted with regard to paleoclimatic pattern (Sonntag and others, 1978).

A number of ^{14}C dates exist from North Africa, which permit age interpretation of landscape elements. Measurements of phases with geomorphodynamic stability or activity (fluctuation of pedogenic and erosional phases) in Iberia and Morocco are described by Fölster and Gaouar (1975) and especially by Rohdenburg (1977), as well as Rohdenburg and Sabelberg (1979). ^{14}C results of soils, paleosols, gravelly main accumulation sediments, younger loess-like blankets, and groundwater samples of Tunisia are reported by Scharpenseel (1972), Scharpenseel and others (1972), Scharpenseel and Zakosek (1979), Brosche and Molle (1975), Brosche, Molle, and Schütz (1976), or Molle and Brosche (1976). Nile terrace dates stem from Fairbridge (1962), and more comprehensive paleoclimatic evaluations of the greater Sahara, including climate curves and histograms of regional ^{14}C dates, undertaken by Geyh and Jäkel (1974; 1977), Jäkel (1978), Sonntag and others (1978, in press), and Pachur (1979). Van Zinderen Bakker (1979) has tried to parallel climatic evolution in northern and southern Africa, based on available ^{14}C ages.

An attempt was made to study all available ^{14}C dates of paleosols, sediments, fossils, and groundwater samples of Tunisia regarding frequency distribution of obtained dates with reference to sample age.

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Paleosol dates of a larger collection of new samples are under scrutiny and will substantially expand the reference base.

RESULTS

Figures 1 and 2 indicate frequency versus age of groundwater dates, taken from wells, embedded in Mesozoic (especially Cretaceous), Tertiary and Quaternary formations (Scharpenseel and others, 1972). A high frequency of a certain age period suggests a correlation with humidity and presence of vegetation. Biotic decomposition of vegetation alone may liberate $^{14}CO_2$ dissolved in groundwater. Table 1, in which all available Tunisian ^{14}C dates are summarized, refers to dates of paleosols from north and central Tunisia (Scharpenseel, 1972; Scharpenseel and Zakosek, 1979). Also listed are samples of charcoal, mollusk shells, and calcareous crust, derived from geomorphic sequences in the Djeffara,

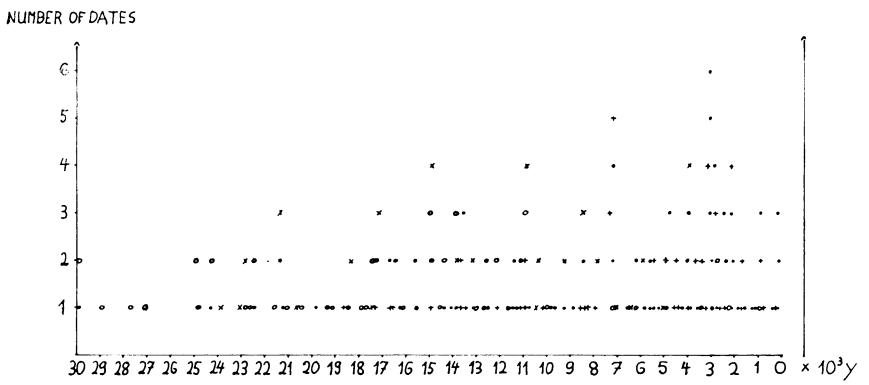

Fig 1. Frequency distribution of groundwater dates (Tunisia)
(● Quaternary, + Tertiary, ○ Cretaceous carrier sediments)

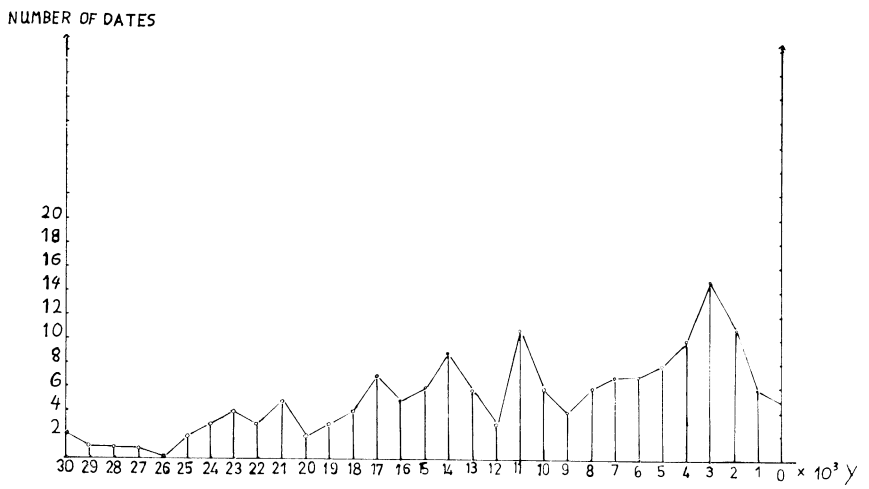

Fig 2. Histogram of groundwater dates (Tunisia)
number of dates each full thousand ± 0.5 thousand years

TABLE 1

Frequency of dates versus humid phases in Tunisia

Dates of Tunisia, sediments, paleosols (17 samples) Brosche and others	Dates of Tunisia, paleosolos (25 samples) Scharpenseel and others	Dates of Tunisia, groundwater (166 samples) Scharpenseel and others	Events of agreement
365 - 780 (2×)	670 - 730 (2×)	700 - 1200 (7×)	×
1100 - 1950 (2×)	1000 - 1700 (4×)	2000 (6×)	×
	2200 - 2470 (6×)	2800 - 3200 (11×)	?
3700 - 4700 (3×)	3400 - 4550 (5×)	4000 (5×)	×
	5050 - 6450 (each 1×)	7100 - 7300 (6×)	×
7500 - 9000 (5×)	7800 - 9000 (4×)	8300 - 8600 (5×)	×
		10,700 - 11,100 (8×)	
10,800 - 13,800 (2×)		13,000 - 14,000 (10×)	×
		15,000 (4×)	
		17,200 - 17,900 (7×)	
21,400 (1×)		21,000 - 21,500 (5×)	×
	22,700 (1×)	22,400 - 23,200 (6×)	×
25,600 (1×)		24,000 - 25,000 (5×)	×
29,800 (1×)		28,900 - 30,000 (3×)	×

around Matmata (Brosche and Molle, 1975) in the region of the Djebels, Chambi, and Mhrila (Molle and Brosche, 1976), as well as in the Kroumerie East of Tabarka (Brosche, Molle, and Schütz, 1976).

The Tunisia dates indicate that the following periods most probably were characterized by a humid climate and a highly vegetated landscape, with aquifers in sediments.

Years BP	Period
600 - 800	Q* T**
1100 - 2500	Q T
3400 - 4700	Q T
7500 - 9000	T Q C†
10,700 - 11,100	T C
13,000 - 14,000	T Q C
15,000	C T
21,000 - 21,500	C Q T
22,400 - 23,200	C T
28,900 - 30,000	C

* Q = Quaternary
** T = Tertiary
† C = Cretaceous

Due to the small soil sample number, which agrees well, however, with the few available dates, the following time periods probably fit the same description. They require confirmation from the larger second set of samples, presently under study.

2800 - 3200	Q T
5000 - 6400	Q T
17,200 - 17,900	C T
24,000 - 25,000	C T

Compared with paleoclimatic schemes, conceived by various authors for the greater Sahara (fig 3), the Tunisian dates collected by Brosche and others and Scharpenseel and others, representing moisture and vegetation, deviate from the Saharan paleoclimatic setting.

Period	Climate	Authors	Period	Climate	Authors
3700 - 4700	humid	Brosche and Geyh	3700 - 4700	arid	Geyh and Jäkel
3400 - 4500	humid	Scharpenseel and others			
2800 - 3200	humid	Scharpenseel and others	2800 - 3300	arid	Jäkel

Good agreement exists among preliminary Tunisian paleosol dates, Tunisian groundwater, charcoal, mollusk, and calcrete dates. The Saharan date collection is obtained for the following age ranges.

Period	Authors	Period	Authors
1100 - 2500	Brosche and others Scharpenseel and others	1500 - 2500	Geyh and Jäkel
5000 - 6400	Scharpenseel and others	5000 - 6000	Sonntag and others
7500 - 9000	Brosche and others Scharpenseel and others	6700 - 8500 8500 - 10,000 7000 - 11,000	Flohn; Sonntag and others Jäkel; Fairbridge
10,700 - 11,100	Brosche and others Scharpenseel and others	7000 - 11,000 8000 - 12,500 10,800 - 11,200	Flohn; Sonntag and others Jäkel; Fairbridge Rohdenburg
13,000 - 14,000	Brosche and others Scharpenseel and others	13,000 - 14,000 12,500 - 16,000	Jäkel
15,000	Scharpenseel and others	14,500 - 16,000	Geyh and Jäkel; Jäkel
17,200 - 17,900	Scharpenseel and others	17,500	Rohdenberg
24,000 - 25,000	Scharpenseel and others	24,000 - 25,000	Jäkel

This paper summarizes the available data on past fluctuations of active pedogenic and erosional phases. Emphasis has been on the soil provinces of Tunisia. Current studies of partially loessic profiles with

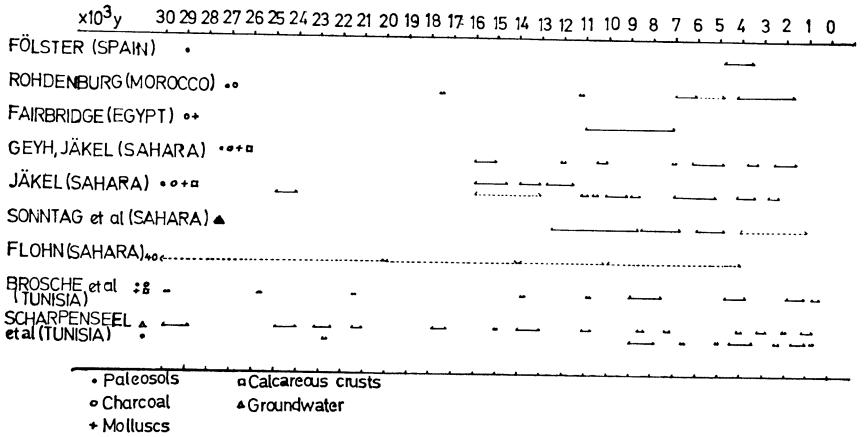

Fig 3. Age spans covered by radiocarbon dates

three and more clearly distinguishable paleosols in central Tunisia will further elucidate the paleoclimatic calendar of this presently xeric and aridic North African region.

The humid spells during the last glacial postulated by us infer the pluvial concept if considerations of stratification, soil genetics, and texture are ignored. Red-brown loamy paleosols from the postglacial, as well as mollic paleosols in Holocene terraces and loessic blankets of central Tunisia suggest a certain parallelism between Tunisian and temperate European paleoclimates (Rohdenburg, 1970; Brunnacker, 1973; Scharpenseel and Zakosek, 1979).

CONCLUSION

A compilation of available radiocarbon dates pertinent to paleoclimatic fluctuations in Tunisia and North Africa was made. The data suggest humid pedogenic phases especially during the following years BP:

2200 to 2500
3400 to 4700
7100 to 9000
10,800 to 14,000
about 15,000
17,200 to 17,900
21,000 to 25,000
28,900 to 30,000

These intervals are not confirmative *sensu strictu* for the classic pluvial concept. Neither are they sufficient for its abolishment in favor of more parallel trends to the temperate climate of the past. More information from paleosol dating is, undoubtedly, necessary.

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