Pact 33 - I.a.5 : M. Hjelmroos and L.G. Franzén

Desert Formation and Soil Damage in Central Tunisia During the Holocene

Places which belong ecologically to marginal areas offer an extremely good opportunity for investigating how sensitive human beings are to environmental variations and how fragile human culture is in those areas which suffer frequent alterations in biotope. North Africa is one of those areas where the origin and development of human cultures can be directly correlated with variations in climatic conditions. The greatest and most serious problems today within the northern part of this area are desert formation and soil damage resulting mostly from intensive human activity.

A 2 m sediment core was taken from Chott Nejla in Central Tunisia. The material contains information of environmental development from c. 16000 BP to the present. Preliminary pollen-analytical studies confirm that deforestation did not commence before 4000 BP. According to preliminary sedimentological investigations traces of at least three high sea-level periods can be seen.

Palaeoenvironmental information from north Africa during the Holocene is mainly based on palaeohydrological investigations and hydroclimatic interpretations. A relatively through and precise reconstruction of past climate in space and time is based on the analysis of 54 limnological sites (Lézine and Casanova, 1989 and the litterature cited in it) from which lacustrine, palustrine and arid conditions have been investigated, and the uncertainties connected with the use of the ^{14}C dating method in intertropical Africa has been taken into account. The data have a firm chronological control and correlate well with the results of a global atmospheric circulation model simulating the hydrological conditions for 18000 BP to the present in 3000 years intervals (Kutzbach and Street-Perrott, 1985). The evidence for conditions of high sea-level within the three physiogeographic units of north Africa (after White, 1983) is shown in Fig. 1.

Palynological data for the area, pollen diagrams with a well dated stratigraphy, are relatively rare and mainly concentrated in the western part

of the South-Sudanian and Sahelian zone as well as in the eastern part of the Sahelian zone. The results demonstrate the extreme sensitivity of these ecoclimatic zones to changes in climate during the Holocene (Lézine, 1988 ; Ritchie *et al.*, 1985).

At ca 9000 BP a semideciduous forest suddenly replaced former grasslands at 6° N and between 6° and 21° N latitudes the modern latitudinal vegetation zonation extended 400-500 km further north. The humidity maximum occurred ca 8000-7000 BP. This period corresponds to Atlantic time in Northern Europe. At about 7500 BP the climate started to became drier and more arid. In the subtropical Sahara zone, which was covered by Sudano-Sahelian vegetation, conditions remained virtually unchanged until 6300 BP in the western part and until 6100 BP in the eastern part. Dry conditions became more pronounced after 4500 BP.

The whole of North Africa is rich in archaeological finds. The area having been settled as early as the palaeolithic. The Atlantic coast, the central parts of the Sahara (Mali) and also the eastern part of the Sahara have been well investigated with respect to the history of man during the Holocene (Petit-Maire 1988, Aumassip 1984). Some areas which are now hyperarid with an annual precipitation of about 5 mm and consist of only sand and rock were nevertheless settled up until 3500-2500 BP. Cattle bones have been found from small settlement sites located in the lowest part of seasonally flooded basins or playas in the central and western Sahara which are dated to 8800-8600 BP. In the eastern part of the Sahara domestic, six rowed barley was present in the period 8100-7900 BP. Archaeological finds give evidence of the cultivation of wheat and barley, and cattle-raising immediately after 7800 BP in that part of the Sahara. The modern desert areas seem to have been occupied throughout the year. With the increasing aridity at around 3000 BP reoccupation of the settlement sites in the central and eastern Sahara began.

The northern transition zone to the Sahara is very poorly investigated palynologically. Pollen diagrams with sufficiently reliable chronological data do not exist from the middle part of the Mediterranean zone. The preliminary results presented here are from the central part of Tunis and have been produced as a part of a project dealing with the climate, landscape and vegetation development and the effects of historical and present land use in areas bordering on the Sahara (Fig. 2).

The area investigated is poor in lakes and therefore the sediment core comes from a chott which is a sedimentary plane at the base level of a desert basin with interior drainage. Evapotranspiration is normally higher than precipitation but depending on the amount of annual precipitation, temporary lakes are often found in the central parts of these basins. Because water is continuously removed from these lakes by evapotranspiration while salt from

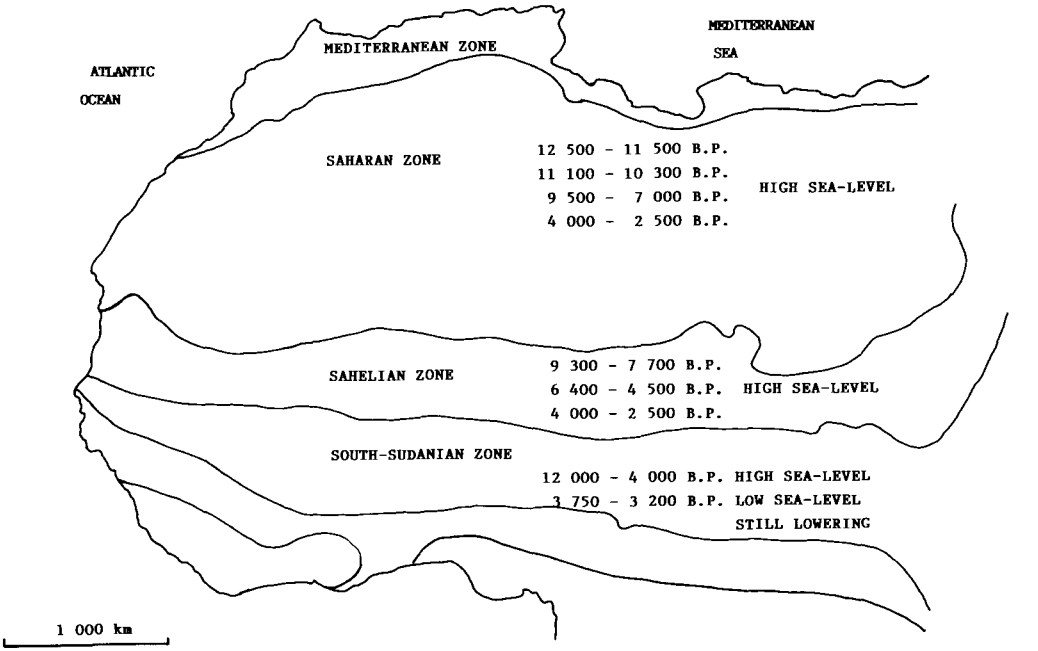

Fig. 1. Modern physiogeographical units of north Africa (after White 1983). Periods of high sea level are shown.

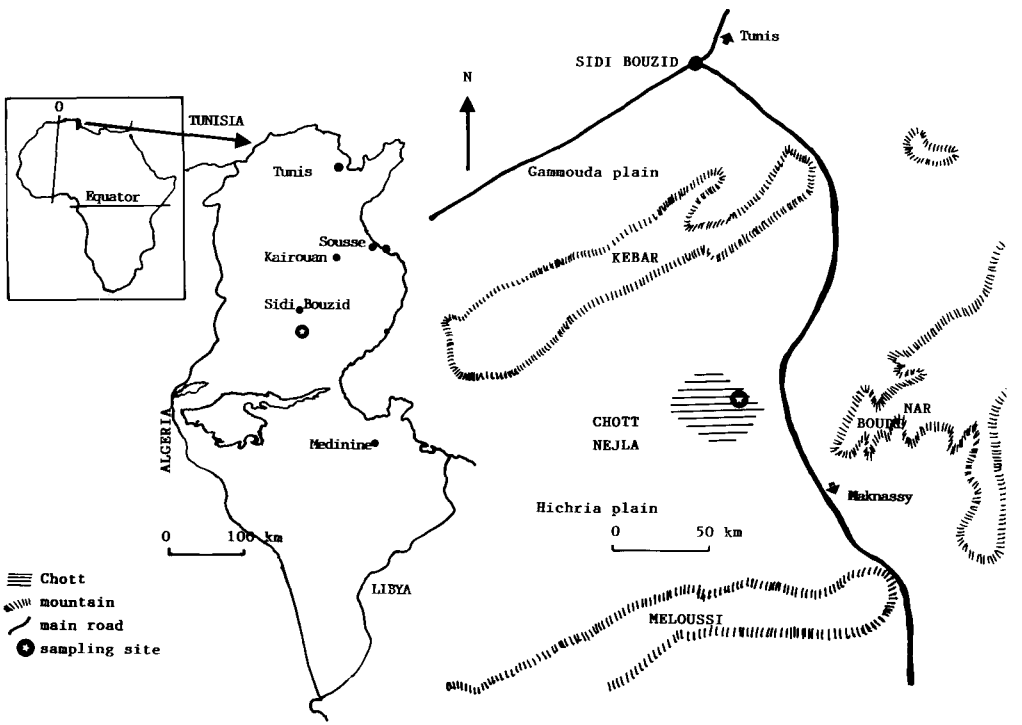

Fig. 2. Location of the investigation area.

the inflowing water remains in the basin these lakes are salt-water lakes. The surface of a chott is almost perpetually moist and particles (pollen, wind transported mineral particles) easily become attached to the surface and in corporated in the sediment simultaneously with the salt accumulation. The chotts are mostly composed of stratified clay and silt beds deposited in the lakes.

Chott Nejla is situated just outside the town Sidi Bouzid (38°75′ N, 7°95′ E) about 320 m a.s.l. The area has a very flat surface and the vegetation is very poor consisting of species of Compositae, Chenopodiaceae and Caryophyllaceae. Intensive sheep grazing ensures that the natural vegetation is even more sparse than under normal conditions. Steppe vegetation is conspicuous in the surrounding areas while, on the higher terrain, some scattered *Acacia* and *Eucalyptus* trees are found.

The climate is semi arid and the annual precipitation today is 232 mm but varies greatly. The annual dry season lasts 3-4 months. The mean annual temperature is +18° C with summer temperatures above +30° C.

The sediment core, which is two metres long, will be carefully dated by means of ^{14}C (tandemacc.) and thermoluminescense. At present only a few datings are available. On the basis of these it appears that the core covers the period from ca 16000 BP to the present (Fig. 3). The rate of sedimentation seems to have been relatively even with the exception of the last 100 years, during which a layer of about 30 cm has accumulated. The quartz particle analyses (the total amount and long distance transported) show that there has been intensive external deposition of quartz material with a particle diameter of 0.074 mm during recent times. This may be a result of the French colonization in Tunisia over the past 100 years or so. In connection with this intensive olive cultivation was introduced with a system of landuse which leads to increased wind erosion and increased mineral transportation. This phenomenon also provides a striking example of the commencement of desert formation which is primarily caused by unsuitable landuse techniques.

A closer investigation of quartz particles will also provide information about water level changes. It has been demonstrated that the form and brightness of quartz granules depends to a high extent on climatic conditions (Franzén, in prep.). Round grains seems to have been transported under dry conditions (wind transport) while the more angular ones have been transported during more humid periods (fluvial transport). On the basis of this, three periods with high sea level have been preliminarily found in Chott Nejla (Fig. 4).

The pollen analytical results are still very preliminary. Only the levels which will be dated have been investigated. Contrary to exceptations the pollen concentration is relatively high and the pollen grains are well preserved.

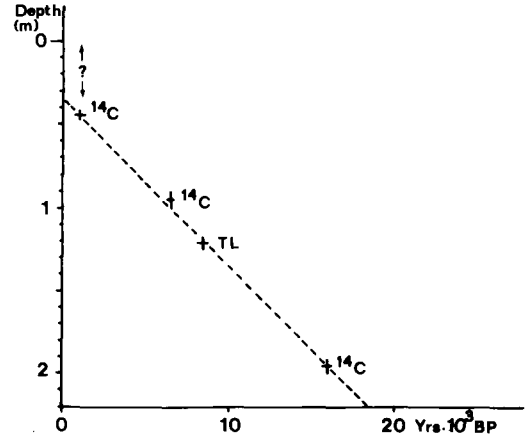

Fig. 3. The available ^{14}C and thermoluminescence (TL) dates plotted against depth with a graphically fitted time-depth curve.

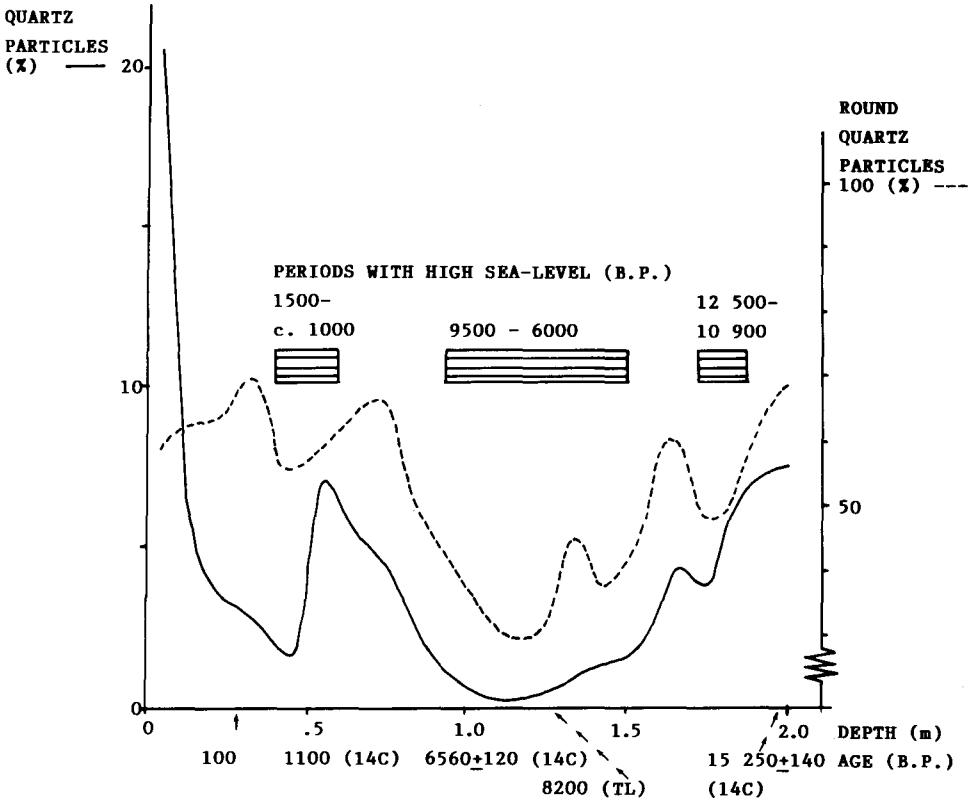

Fig. 4. Amount of angular quartz particles 0.074 mm and round quartz particles in the size range 0.25-0.50 mm. Periods of high sea level are marked.

The Sidi Bouzid area was dominated by an arboreal vegetation mixed with herbs (cf. pseudo-savanna) until at least 4000 BP. Haynes (1987) has produced similar results from north-western Sudan where the climate changed to became considerably drier after 4300 BP. From 4000 to the present the vegetation has been dominated by grasses and other herbs. The more recent samples show a strong representation of elements which prefer saline soils.

The investigation will continue and will focus particularly on the human impact of the natural vegetation over the last 2000 years.

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