UPPER PLEISTOCENE AND HOLOCENE HISTORY OF THE BILMA REGION (KAWAR, NE-NIGER)

EVOLUTION DE LA REGION DE BILMA (KAWAR, NE-NIGER) AU PLEISTOCENE SUPERIEUR ET A L'HOLOCENE

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Abstract

A 42 m drilling was performed in the depression of Bilma, Kawar, NE-Niger. The sediment and pollen records show that after an initial deposition of dune sands there were repeated lake phases which terminated by desiccation and consolidation of spring mounds. The pollen record indicates a continuous presence of savanna vegetation. The record probably covers the period between the Upper Pleistocene and the Late Holocene. The climate was characterised by a monsoonal summer rain regime giving effective rain fall of about 450-500 mm per year. Groundwater recharge was possible but estimates of the amount of water resources are difficult because of the karstic system of the escarpment and the nearly unknown hydrogeological situation.

Résumé

Dans la dépression de Bilma, Kawar, NE-Niger, un forage de 42 m a été réalisé. La séquence couvre la période entre le Pléistocène supérieur et l'Holocène tardif. Après une phase initiale de dépôts des sables dunaires, trois phases lacustres sont visibles, chaque fois terminées par une période de dessiccation et formation de dépôts de sources en buttes. Les investigations polliniques montrent que, pendant toute la période, une végétation de savane était dominante. Le paléoclimat était caractérisé par un régime de mousson et des précipitations effectives d'environ 450-500 mm par an ainsi que des invasions de dépressions atlantiques. Une recharge de la nappe phréatique était possible, mais la connaissance insuffisante de l'hydrogéologie et du système karstique rend une estimation des ressources en eau très difficile.

INTRODUCTION

The steadily growing demand of water in deserts forces man to exploit fossil non renewable resources. Often the amount of groundwater remains unknown, especially when the hydrogeological situation of the region is almost unrevealed. In these cases the palaeoenvironmental history provides necessary information about the periods of a possible recharge of groundwater.

The depression in front of the Bilma escarpment in the southern Kawar, NE-Niger, which today belongs to the dryest parts of the Sahara, has a longlasting history of palaeolakes [1, 2, 9]. These records show the dependence of those groundwaterfed lakes on the aquifer in the escarpment and the different reaction of the singular lakes.

In December 1988, a 42 m drilling was established on the top of the hill of Bilma for the local water supply. The drilling was supervised by Benamour (Min. Hydrol. Niamey) who collected samples during the drilling and transmitted them to the Geol. Dept. of Niamey University for further investigations. This paper presents the first results including the stratigraphy, the pollen record and a conclusion concerning the palaeoenvironmental and palaeoclimatological history. Other investigations will concern the sedimentology as well as the content of algae and pigments.

STRATIGRAPHY

Basic layers of bleached dune sands and reworked soil material are overlain by a two times repeated sequence of lake sediments. Each lake

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deposit is covered by a layer of consolidated silt, sand and iron oxides representing the cementation of a spring mound. The upper lake sediments are overlain by sandy peats and a 7 m deposit of dune sand. The record indicates similar hydrological conditions during most of the time. Lakes were groundwaterfed by large artesian springs which were covered by cemented silts sand and iron oxides after the desiccation fo the lake. These spring mounds are still the basis for the horticulture of the oasis.

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THE POLLEN RECORD

The samples were prepared with the classic combination of HF^-, HCl^-, and acetolysis treatments. Pollen grains were counted to the point of consistency in the spectra. The pollen sum includes all pollen except fern spores and varies between 250 and 1,200, (fig. 1).

The mediterranean elements include Pinus and Olea; the medit.-presaharan Artemisia, Erica, Ephedra, Moltkiopsis; the saharan Acacia, Balanites, Maerua, Capparis, Cassia, Fagonia, Aerva, Cornulaca, Salvadoraceae, Monsonia, Tribulus; the sahelian Cordia, Piliostigma, Combretum, Guiera, Ziziphus, Indigofera, Boscia, Commelina, Rogiera, Mitracarpus; the sudanian Borassus, Mimosaceae, Diospyros, Khaya, Celtis, Alchornea, Hymenocardia, Antidesma, Securinega, Annona, Hewittia and Drosera, and the guinean elements Daniellia, Nauclea, cf. Lophira, Rubiaceae and Sapindaceae. The pluriregional-ubiquitous elements include the Capparidaceae, Cleome, Compositae, Convolvulaceae, Cruciferae, Cucurbitaceae, Euphorbiaceae, Iridaceae, Labiatae, Liliaceae, Malvaciae, Ocimum, Papilionaceae, Plantago, Polycarpaea, Polygala, Resedaceae, and Solanaceae.

The sequence is dominated by the elements of an open vegetation, especially the Gramineae. Cyperaceae and Chenopodiaciae/Amaranthaceae are of minor importance. A comparison with the present pollen precipitation [7, 8] excludes the regional presence of the savanna-desert boundary. Over the whole period, a savanna vegetation in different types was predominant for the region.

POLLEN ZONES

1. During the accumulation of the basic dune sands a sparse Acacia-Maerua savanna covered the region. Some sudanian trees and bushes like Diospyros of Annona may have been present around wet places near the escarpment.

2. First period of lake development with an intercalation of dune sand. Around the lake there was a sudanian alluvial vegetation present including Diospyros and Alchornea. Drosera is an indicator for poor soil types either on sand or on swamp in the sudanian zone. The rocky areas were covered by an open sahelo-saharan savanna of the Acacia-Maerua-Capparis type. The water surface of the lake trapped a portion of pollen which was transported over long distances. At the end of this period the lake desiccated and the spring was covered by a layer of cemented silt, sand, and iron oxide.

3. Second period of lake development. The sudanian alluvial vegetation again was present around the lake marked by Diospyros and Alchornea, and a sahelian type savanna covered the plain of the Tenere. The part of the pluriregional or ubiquitous pollen also confirms the open character of the vegetation. After the desiccation of the lake the spring was again covered by cemented sand and silt. The desiccation and the formation of a Typha-swamp is indicated by the large amount of Typha pollen.

4. The third lake phase is again characterised by the formation of a sudanian typed alluvial vegetation and of a sahelian savanna on the plains. To the end of this period the saharan and sahelian elements became more and more important. Also the portion of the pollen transported over long distances from the North and the South increased. After the desiccation of the lake the site was covered by a sandy peat. The sample of the peat layer shows a saharo-sahelian vegetation with only a few sudanian elements.

DATATION

A series of radiocarbon datations and a stratigraphical comparison with similar profiles from the region [1, 5, 7] are the base of a first chronology. The datations are made on organic material (6, 21, 34) and carbonates (7, 10) by Prof. Fontes (Labo. Hydrol. Géochim. Isotop. Orsay, France). They represent a logic sequence and confirm the Early and Middle Holocene age of pollen zone 4 (3740 ±150 B.P. / 6860 ±115 B.P. / 8590 ±120 B.P.). The lower part of zone 3 and zone 2 belongs to the Upper Pleistocene (23680 ±3850 B.P. / 21490 ±2940 B.P.). The marge of error restricts a further discussion of the age of the lower part of the sequence.

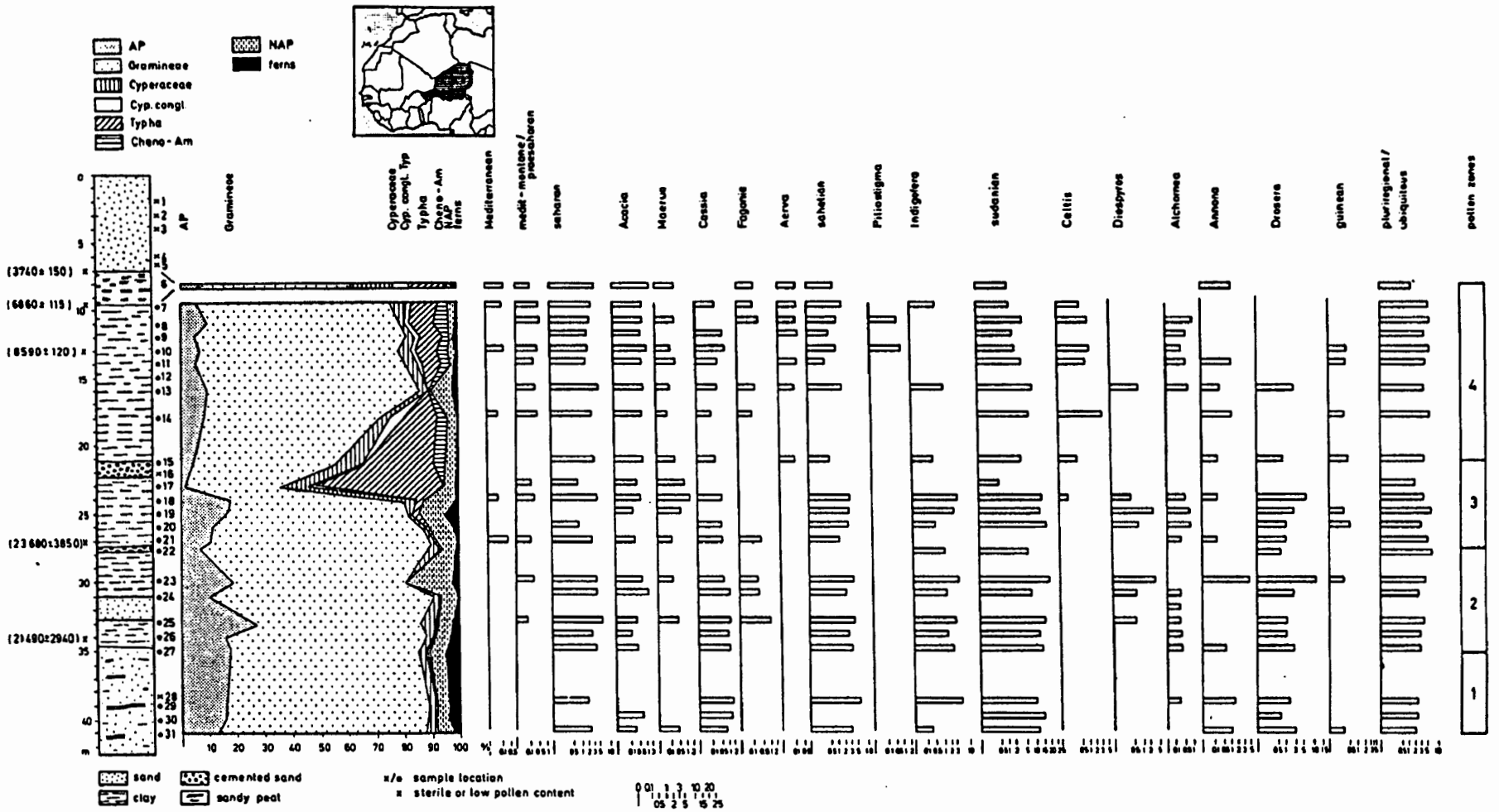

Figure 1 : Simplified pollen diagram of the Bilma well (Kawar, NE-Niger) (18°41'N/12°55'E).

PALAEOCLIMATOLOGICAL IMPLICATIONS

The vegetation types reconstructed for the Upper Pleistocene and Holocene indicate that the climate was dominated by a monsoonal summer rain regime. One has to count on an equivalent of a precipitation of about 450-500 mm per year. But there were also important invasions of atlantic/mediterranean depressions, which are indicated by the elements of the long distance transport in the pollen spectra.

DISCUSSION

One has certainly to count on some disturbations and degradations of the plant cover during the desiccation phases of the lakes, but the repeated reestablishment of the savanna environment is evident.

A comparison with similar profiles is difficult. The nearest profile comes from East of Lake Chad [4] and covers the Holocene. Comparable sites in the northern Sudan [6] are also of Holocene age. These pollen records were interpreted in terms of shifts in the zonal vegetation during the Holocene.

The Bilma record in contrary indicates that one has not to count on a simple shift of vegetation belts but on a principally different mosaic of vegetation types during the Upper Pleistocene and Middle Holocene.

CONCLUSION

The Bilma record shows that during the Upper Pleistocene up to the Middle Holocene there were different lake formations and a repeated establishment of a savanna vegetation which included various sudanian elements. During that period groundwater recharge was possible. Due to the compartimentation of the aquifers in the escarpment and the depression, and the fact that the escarpment is highly karstified, it is very difficult to estimate the amount of groundwater available. The exploitation of this fossil resource has to be very careful.

Acknowledgements

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