Preliminary Report on Mineralogical and Pollen Analysis of the deposits from Orog Nuur lake, Mongolia

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Introduction

The salt water Orog Nuur lake in Mongolia is at the end of the Tuin Gol river, which passes through Bayankhongor aimag and ends in the basin parallel to the Gobi Altyan mountain range. Also referred to as Shar Burd Nuur is nestled in the foothills of Ikh Bogd Uul (3957m) in Bogd sum, about 41 km from Bogd town. At 1210 m altitude, Orog Nuur lake (54 square miles/140 sq. km) is one of the biggest lakes in the aimag (Fig.1). Studies of satellite imageris and archaeological explorations have revealed that the lake was many times larger than the present size. Hundreds of human burials of iron and bronze ages close to the lake reveal that the lake must have supported the human life in the past. As a part of Joint Geo-archaeological Italian-Mongolian investigations, the study of the sediments of Orog Nuur lake was undertaken to know the climatic history of the past as reflected in the changes in the mineralogy and pollen contents in the lake sediments. Some work has been initiated earlier by Gegeensuvd (2004).

The sediments were collected by taking a trench (1x1 m) about 500 m inside the north-western periphery (Lat. 45^0 04' 42.5" N and Long. 100^0 34' 56.8" E) of Orog Nuur lake (Fig.2). The sequential and undisturbed sediment samples were collected at a specific interval of 10 cm from freshly exposed stratified section. A total of 19 samples were collected from the profile of the trench from surface to the bottom by taking maximum precaution to avoid contamination. After 2 meters, the samples could not be collected due to the occurrence of ground water. After proper documentation all samples were subjected to mineralogical and pollen analysis.

Methodology

Mineralogical Analysis

All samples are clayey silty having neutral pH. The lowermost layer, however, is alkaline with 8.0 pH. XRD analyses of Orog Nuur lake sediments were carried out at the Deccan College Research Institute, Pune, India, using a RIGAKU DMax IIVC XRD System, operated at 45 KV, 30 mA, at a scan speed of 2'/sec. Mineralogical analysis was done

by search-match program of the XRD machine. All sediments were mineralogically similar containing varying amounts of chlorite, muscovite, quartz and plagioclase. Relative percentages for each mineral were computed to understand their variation in the sediments (Table.1). The mineral pattern of the sediments is typical of the weathering of local rocks such as granite and gneiss which occur in the adjacent Gobi Altyan mountain range. Calcite was also present in the lake sediments in varying amounts.

Pollen Extraction:

The samples were treated with various chemicals for extraction of pollen according to the maceration technique described by Faegri and Iverson (1964), Traverse (1988) and Deotare (1995) specially designed for minerogenic sediments as all samples from Orog Nuur Lake are mineral rich.

Samples were treated with 10% Hydrochloric acid (HCl) to remove carbonates and 10% Sodium hydroxide (NaOH) solution to dissolve unwanted organic matter and at the end with hot Hydrofluoric acid (HF) to remove silica. Finally glycerol treatment was given to make the processed palynomorphs moisture free. Thus slides were prepared by mounting them in glycerin jelly and observed under binocular microscope (CARL ZEISS, JENAMED2) for observation, identification, counting and documentation. Unfortunately it was not possible to have modern plants from the surrounding of the study area. But with the help of available resources, we have identified pollen at family level and some of them remained unidentified due to poor preservation and lack of modern reference collection from Mongolian flora.

Results and Discussion

Mineralogical analyses of the Orog Nuur sediments have shown that all samples from top to bottom are mineralogically similar with different relative contents. Clays containing chlorite and muscovite/ illite are typical are typical of those derived from the granitic rocks. Quartz and anorthite contents are nearly are varying but shows maximum at the lowermost sample (180 cm). Presence of fine grained calcite in these samples is the only indicator of the climatic change. Variations in calcite can be attributed to climatic fluctuations. Calcite has shown sharp increase at 100 cm depth (Fig.3). Another high value is observed at 160 cm. The periods corresponding to these depths could belong to drier climates indicating fluctuating climate.

The overall recovery of pollen is good except fungal spores which are relatively less. Pollen recovery in samples from middle and upper level are fairly good and thus yielded well preserved pollen grains except two sample from bottommost (170-180 cm and 150-160 cm) level where mineralogical analysis has shown

increase maximum quartz and anorthite contents. It is observed that the first 3 samples from top contain high proportion of microfossil and it decreases with depth till sample no. 8 (70-80 cm depth) and again increases up to the depth of 150 cm i.e. sample no.15

Several pollen types have been noted and all are in good state of preservation may be because of near neutral reaction of the deposits and relatively more organic matter indicated by their colour. The pollen types have been identified and recorded on the basis of their morphological features and they are listed in Table.2.

It instructive to compare the results of pollen analyses of the sediments from Indian Thar desert. This project mainly deals with the palaeoenvironmental history of Kanod and Bap-malar playas located in western part of Rajasthan, India. These studies on the Bap-Malar and Kanod playas in the arid core of the Thar desert indicate that they remained saline throughout their existence i.e.18 ka to 6 ka and dried up at least 1000 years earlier than the playas in the eastern part of desert (Deotare et al. 1998; 2004a; 2004b; Kajale and Deotare 1997, Kajale et al. 2004). Though these studies mainly confined to the western part of Rajasthan of the Indian Thar desert, the Orog Nuur Lake sediments and pollen data may not be comparable due to their geographical location but some similarities are noted so far as climatic interpretation is concerned.

The pollen being plant oriented and microscopic male reproductive entity of flowering plants remains intact years together and are recoverable from the sediments. It is one of the best and most reliable parameter available in the present context to study vegetation and climatic aspect of the past.

In the present study, main objective was to test the potentiality of pollen in Orog Nuur Lake deposit, which is proved beyond doubt by recovering well preserved microfossils (Plates1-3). The significant recovery of these pollen grains is most probably because of near neutral reaction of the clayey deposit. After comparing the fossil pollen grains with modern one it is observed that the most of the pollen grains belong to the typical members of wet plants.

The uppermost level (0-20cm) shows the significant pollen grains of the families Tamaricaceae, Poaceae, Cyperaceae, Chenopodiaceae/ Amaranthaceae, Euphorbiaceae, Myrtaceae indicating vegetation of grassland.

The upper level (20-80 cm) shows the dominance of pollen grains belonging to the families of Verbenaceae, Anacardiaceae, Combretaceae indicates the typical members of dry deciduous plants.

The most dominant plants at the middle level (80-130cm) belong to the families like Myrtaceae, Fabaceae, Anacardiaceae, Euphorbiaceae, Bignoniaceae and Magnoliaceae indicating wet evergreen climate.

After comparing the fossil pollen grains with modern one it is observed that the most dominant plants at the lower level (130-180cm) belong to the families like Cyperaceae, Myrtaceae, Poaceae, Anacardiaceae, Asteraceae (Compositae) with some fungal spores indicating wet humid climate.

Pollen recovery from the bottommost samples i.e. sample no. 18 (170-180cm) and 16 (150-160cm) is almost nil because of relatively high alkaline nature of the deposit.

Overall pollen grains of Amaranthaceae/Chenopodiaceae, Cyperaceae, Gnetaceae, Poaceae and to some extent Asteraceae (Compositae) are found throughout the profile indicating mixed flora i.e. wet and dry. For example Amaranthaceae/Chenopodiaceae, Cyperaceae, Poaceae indicate wet climate whereas pollen of Ephedra (Gnetaceae) can grow in semiarid to arid climate. It is therefore on the basis of pollen data so far identified and the nature of sediment suggests that the climatic condition at Orog Nuur Lake seems to be fluctuating. Although the dates for these sediments are not available, there seem to be continuous water in the lake with periodic fluctuating condition which is reflected in the mineralogical and pollen analyses. Although the dates for these sediments are not available, there seem to be continuous water in the lake with periodic fluctuating condition which is reflected in the mineralogical and pollen analyses.
Due to lack of reference flora of Mongolia, some pollen grains remained to be identified which will be undertaken in further studies of the sediments.

Acknowledgement

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Table.1: Variation of minerals in Bogd Lake sediments with depth

Depth cm	Chlorite Rel.%	Muscovite Rel.%	Quartz Rel.%	Anorthite Rel.%	Calcite Rel.%
0	27.1	50.1	32.7	10.1	21.3
10	48.6	70.8	37.9	25.7	31.3
20	37.8	58.3	34.4	20.1	29.3
30	59.4	58.3	44.8	38.5	38.1
40	51.3	45.8	62.1	31.4	33.3
50	54.1	66.6	48.2	40.7	38.1
60	40.5	58.3	56.8	100.0	25.3
70	70.2	91.6	55.1	64.2	55.3
80	70.2	66.6	53.4	61.4	36.1
90	37.8	45.8	46.5	32.8	50.6
100	37.8	37.5	44.8	24.2	100.0
110	81.1	58.3	41.3	35.7	60.1
120	37.8	62.5	34.4	31.4	49.3
130	62.1	100.0	36.2	30.1	29.3
140	64.8	54.1	48.2	29.2	27.3
150	59.4	70.8	55.1	48.5	47.6
160	48.6	50.1	43.1	34.2	74.6
170	100.0	95.8	27.5	21.4	40.1
180	54.1	41.6	100.0	82.8	12.1

Table 2 : Distribution of pollen types in the profile of Orog Nuur lake

No	Depth cm	A	AN	AS	AT	B	BE	BR	CY	E	F	GN	LL	ME	M	MT	PN	PO	S	T	TP	V	FS
1	00	+	-	-	-	-	+	+	+	+	-	+	-	+	-	+	-	+	+	-	+	-	-
2	10	+	-	-	-	-	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-
3	20	+	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	+	-	-	-	+	-
4	30	+	-	-	+	-	-	-	+	+	-	+	-	-	-	-	+	+	-	-	-	-	-
5	40	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-
6	50	+	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+
7	60	+	-	-	-	-	+	-	+	-	-	+	-	-	+	+	-	+	-	-	-	-	-
8	70	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-
9	80	+	-	-	+	-	-	+	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-
10	90	+	-	-	-	-	-	+	+	+	-	+	-	+	+	-	-	+	-	+	-	-	+
11	100	+	-	-	-	+	-	-	+	-	-	+	-	-	-	-	+	-	-	+	-	-	-
12	110	+	-	-	-	-	-	-	+	-	-	+	-	-	-	+	-	+	-	+	-	-	-
13	120	+	+	-	-	-	-	-	+	-	+	+	-	-	-	+	-	+	-	-	+	-	-
14	130	+	+	+	-	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	+	+
15	140	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-
16	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	160	+	-	-	-	-	-	-	+	+	-	+	-	-	-	-	-	+	-	-	-	+	+
18	170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A = Amaranthaceae / Chenopodiaceae, AN = Anacardiaceae, AS = Asteraceae (Compositae), AT = Acanthaceae, B = Bignoniaceae, BE = Betulaceae, BR= Brassicaceae, CY = Cyperaceae, E = Euphorbiaceae, F = Fabaceae, GN= Gnetaceae, LL = Liliaceae, ME = Meliaceae, MG = Magnoliaceae, MT = Myrtaceae, PN = Pinaceae, PO = Poaceae, S = Salvadoraceae, T = Tamaricaceae, TP = Typhaceae, V = Verbenaceae, FS = Fungal spores.

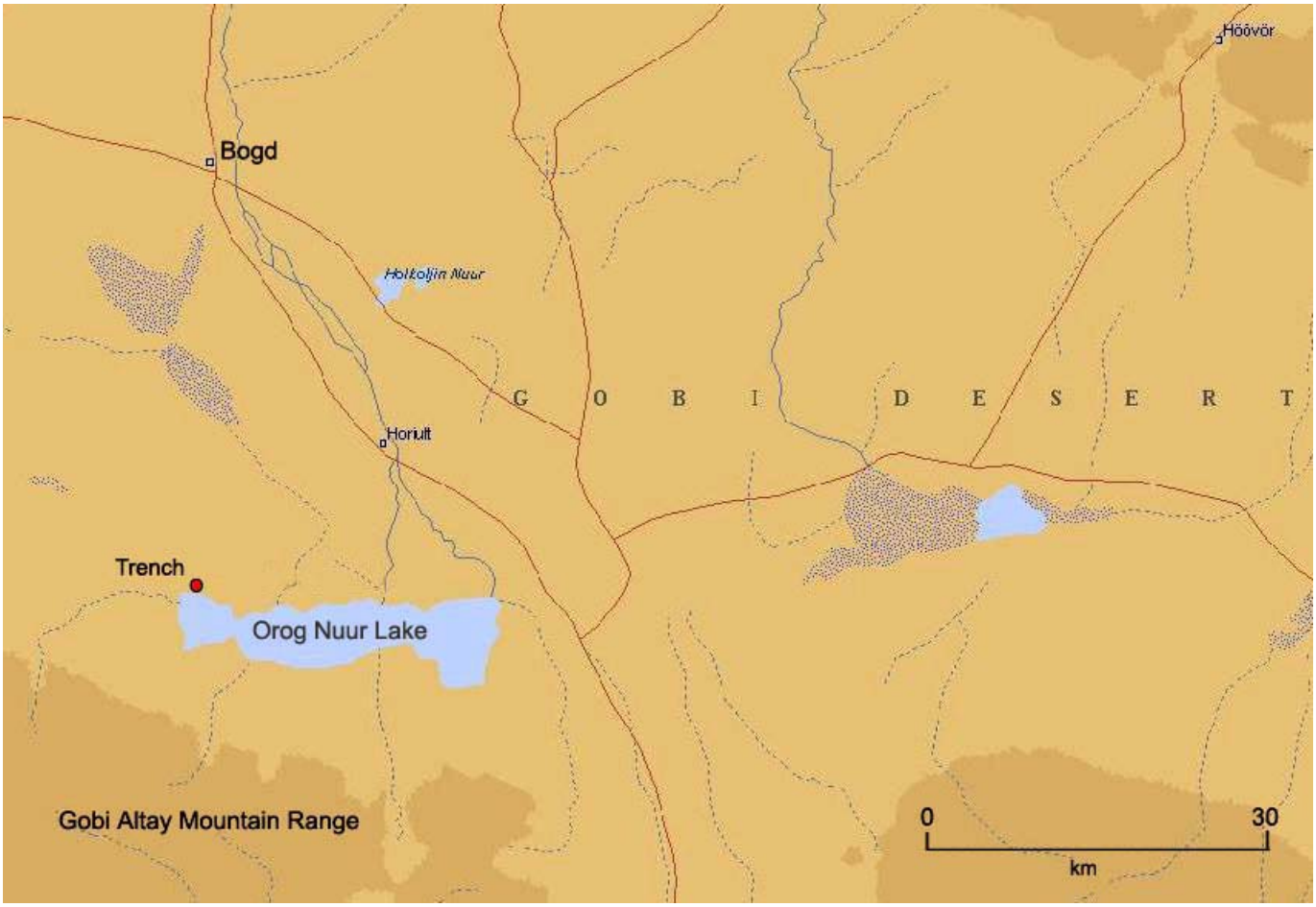


Fig.1: Location of the trench taken for collecting sediments at Orog Nuur Lake

Fig.2: Location of trench is about 500 m inside the north-western periphery of the Orog Nuur Lake

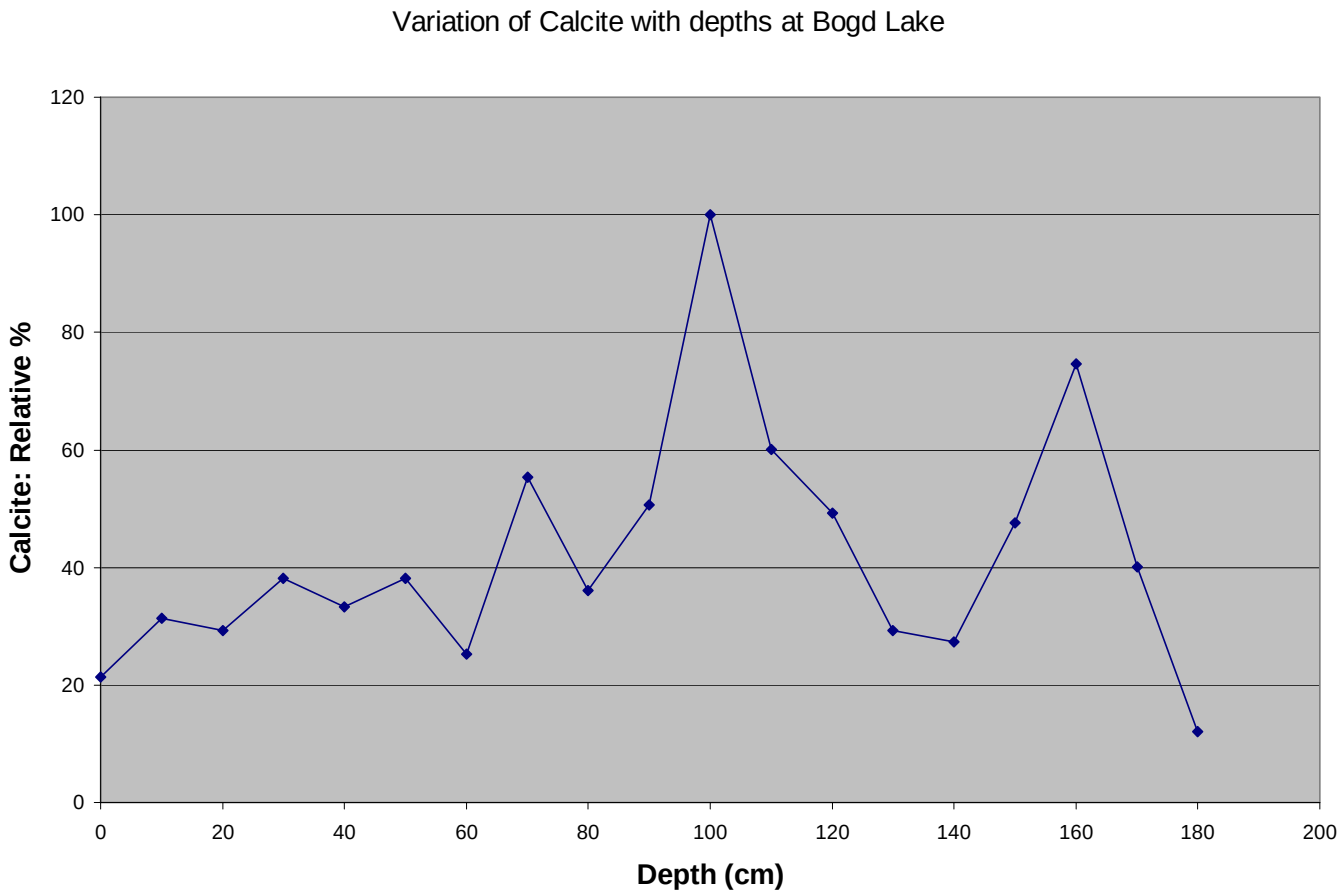
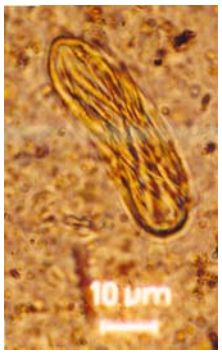


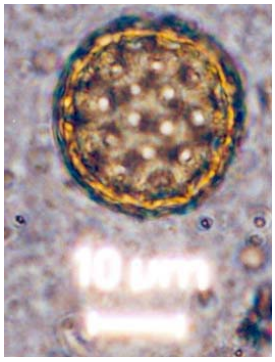
Fig.3: Variation of calcite with depth in the sediments of the Orog Nuur Lake

Plate. 1 : Pollens recovered from the trench at Orog Nuur Lake



a) Acanthaceae

b) Acanthaceae 1

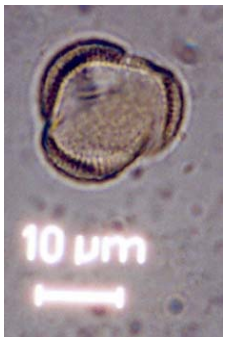


c) Amaranthaceae/ Chenopodiaceae

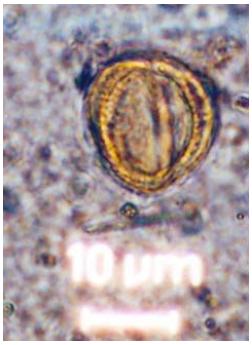
d) Anacardiaceae

e) Arecaceae

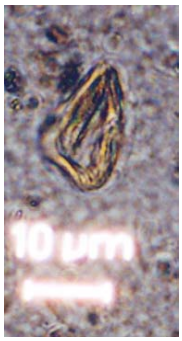
f) Asteraceae



g) Brassicaceae



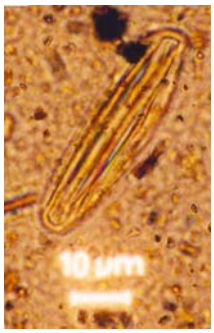
h) Brassicaceae 1



i) Cyperaceae

Plate. 2 : Pollens recovered from the trench at Orog Nuur Lake

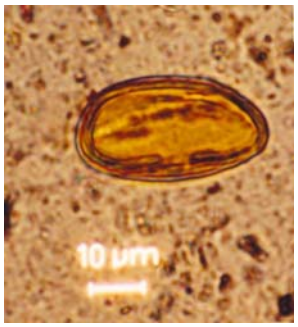
j) Pinaceae



k) Gnetaceae

l) Liliaceae

m) Magnoliaceae

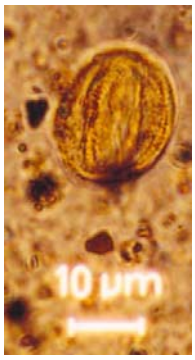


n) Meliaceae

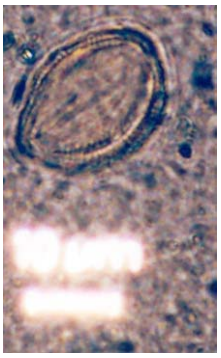
o) Fungal spore

p) Fungal spore 1

Plate. 3 : Unidentified microfossils from the Orog Nuur Lake sediments



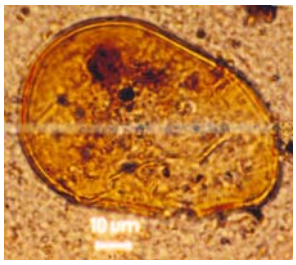
q) Indet 1



r) Indet 2

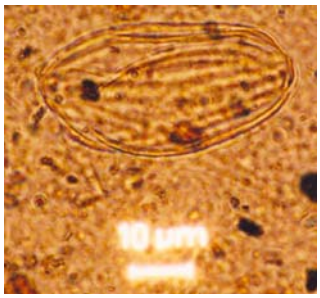
s) Indet 3

t) Indet 4



u)Indet 5

v)Indet 6



w) Indet 7

x) Indet 8

y) Indet 9