The Abdus Salam
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United Nations
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SMR/1884-15

Conference on Milankovitch cycles over the past 5 million years

22 - 24 March 2007

Application of radiacorbon dates for Milankovitch Climate Change

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LATE PLEISTOCENE CLIMATE CHANGE: A CASE STUDY FROM THE INDIAN THAR DESERT, RAJASTHAN

hema achyuthan

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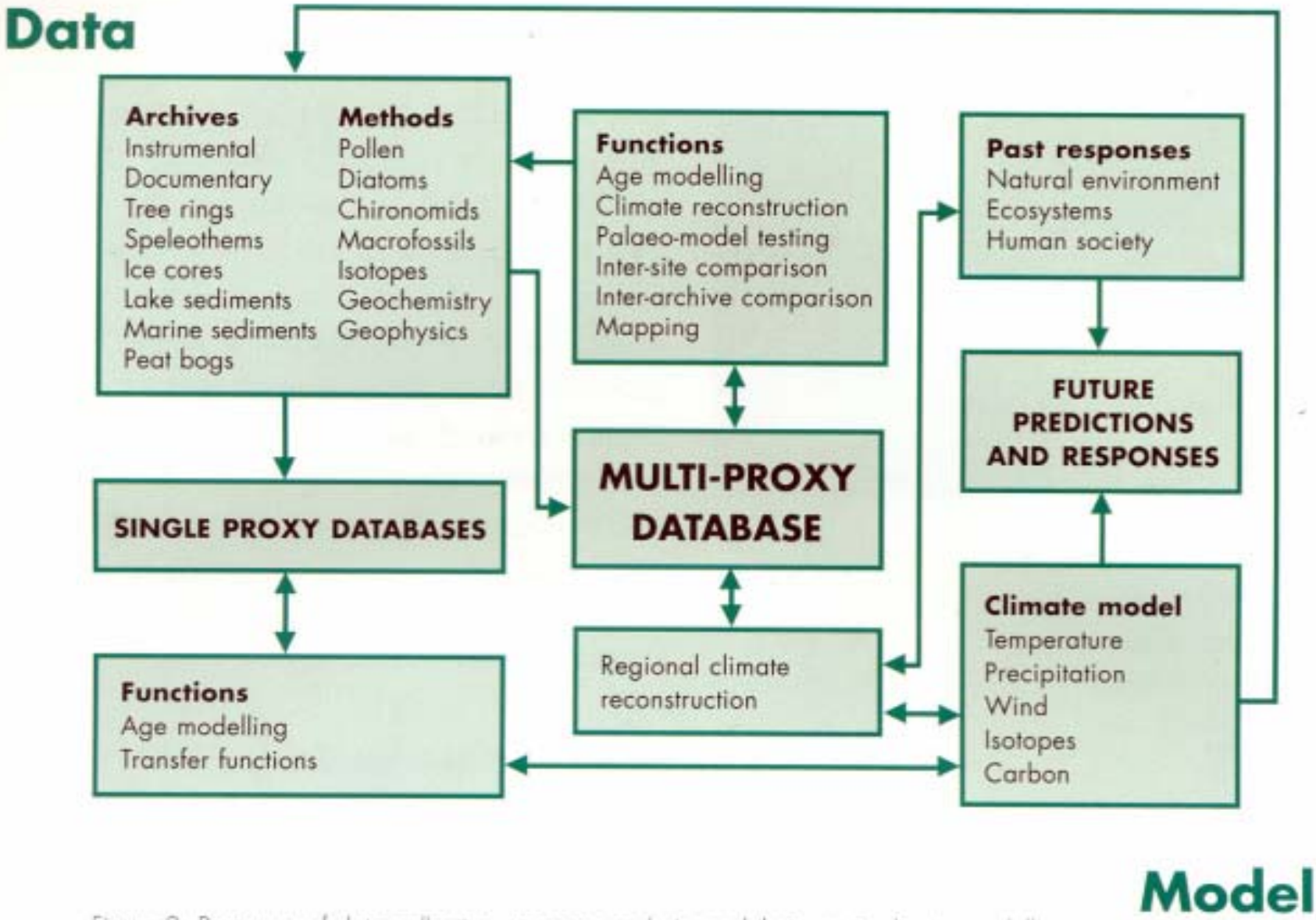
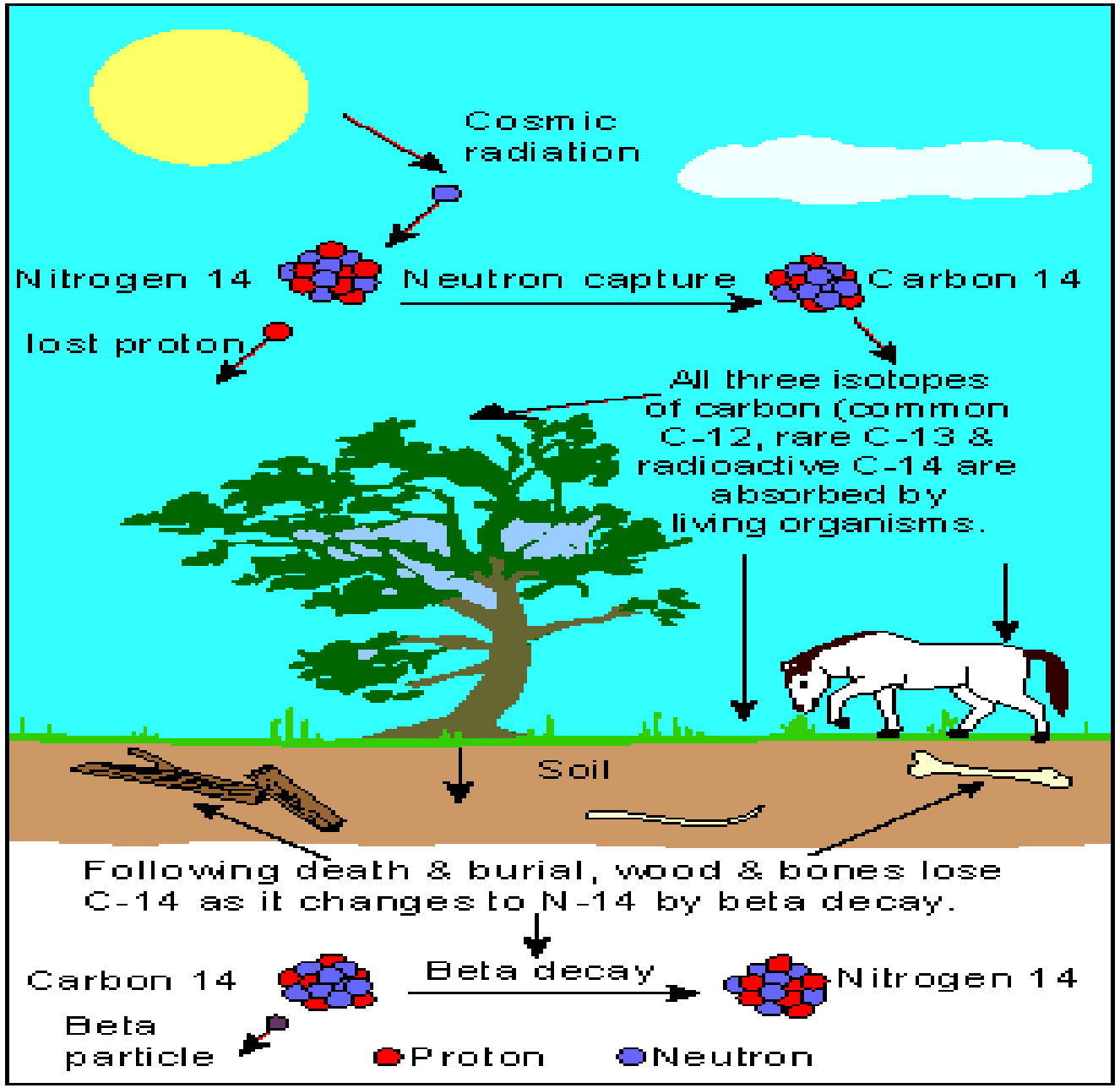
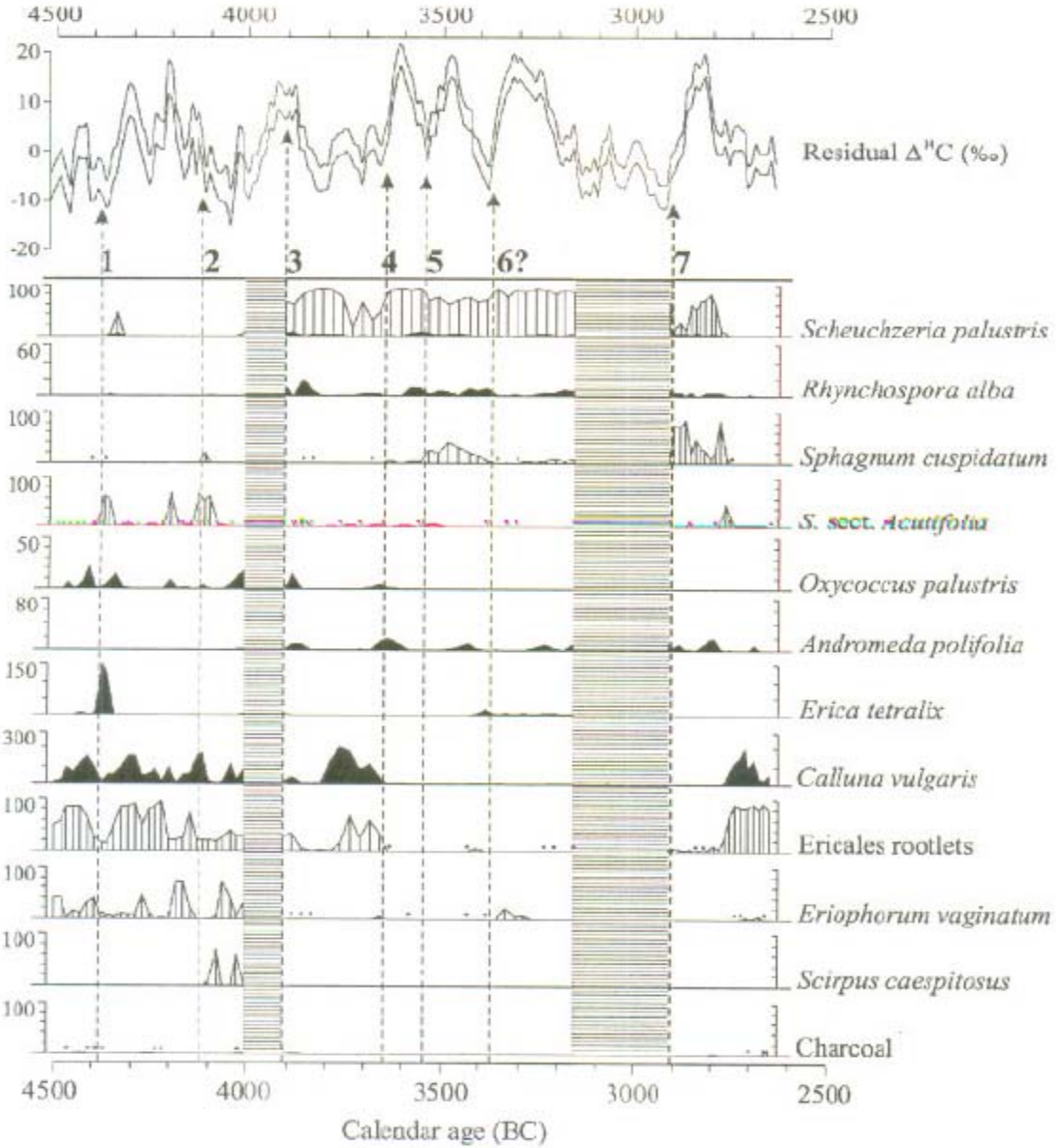


Figure 2: Processes of data collection, storage, analysis, and their use in climate modelling.


Cosmic radiation
Nitrogen 14
Neutron capture
Carbon 14
lost proton
All three isotopes of carbon (common C-12, rare C-13 & radioactive C-14 are absorbed by living organisms.
Soil
Following death & burial, wood & bones lose C-14 as it changes to N-14 by beta decay.
Carbon 14
Beta decay
Nitrogen 14
Beta particle
Proton
Neutron

Changes in the past: Observed

- Recently marine based calibration data back to 50 kyr have been provided by ^{230}Th and 14C dated corals with irregular spacing.
- Millennial-scale climate with Dansgaard-Oeschger (D-O) events in Greenland ice cores.
- ^{14}C data linked to the ^{230}Th Hulu cave chronology show excellent agreement with data from ^{230}Th dated fossil corals back to 33 kyr.
- Marine reservoir age correction have been obtained from a ^{230}Th dated speleothem on Socotra island in the Arabian Sea.



Mid Holocene peat bogs- Netherlands (Blaauw et al., 2004).

Peat bogs

^{14}C wiggle match dated at high precision.

Several wet shifts were inferred- major rise in δ14C archive probably caused by major decline in solar activity.

δ14C rise c.4265-4215 Cal BC;1535-1485 cal BC-wet shifts/cooler climate, decrease in solar activity.

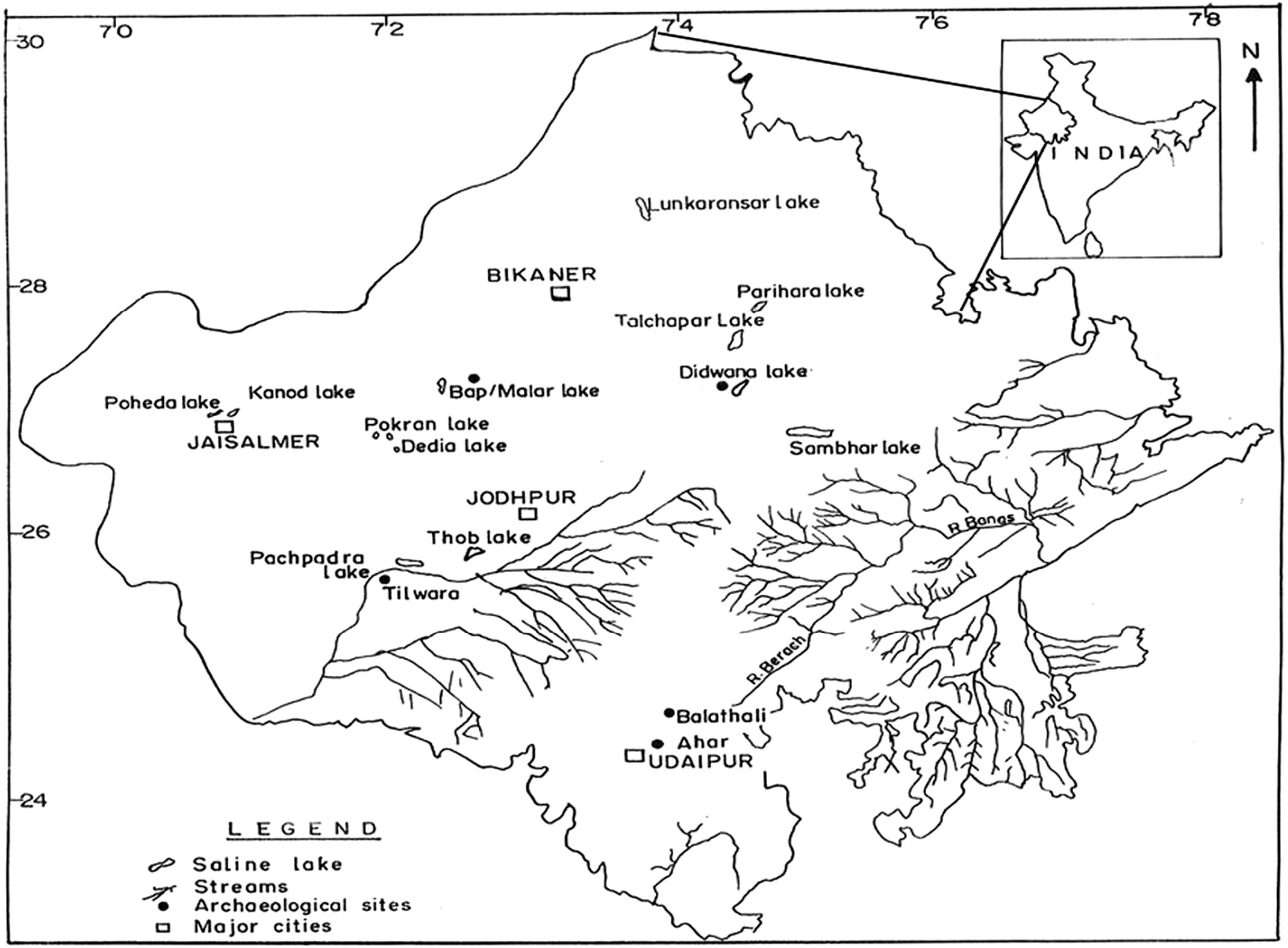
Changes in the solar activity during the Holocene can be reconstructed using the proxy δ14C.

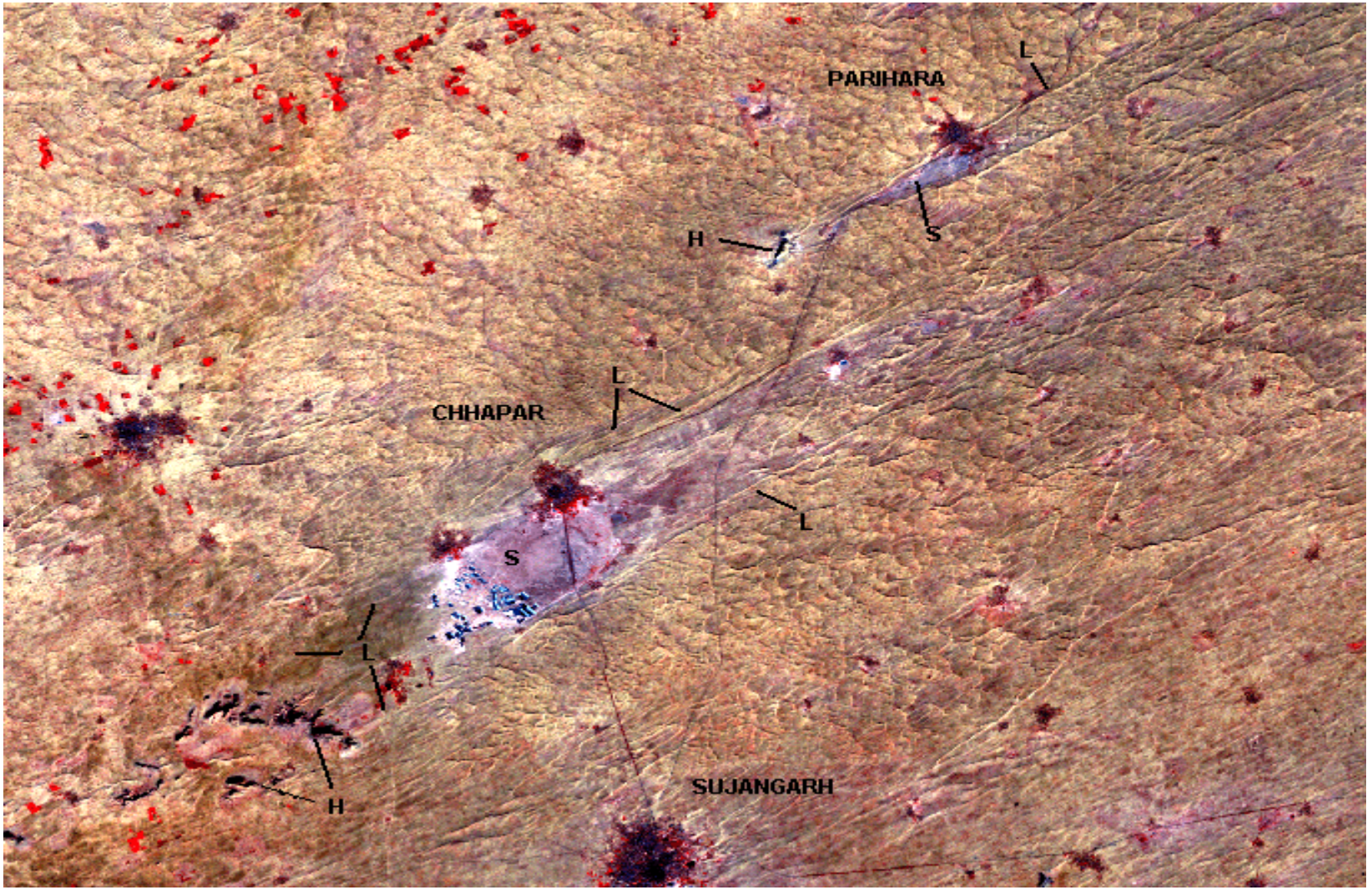
- Sharp rise of atmospheric δ14C ca. 800: due to solar forcing, climate change, considerable rise of groundwater - peat growth started in areas that were already marginal from a hydrological point of view.-Europe (Van Geel et al., 1998.Wiggle match dating (WMD) of organic deposits.

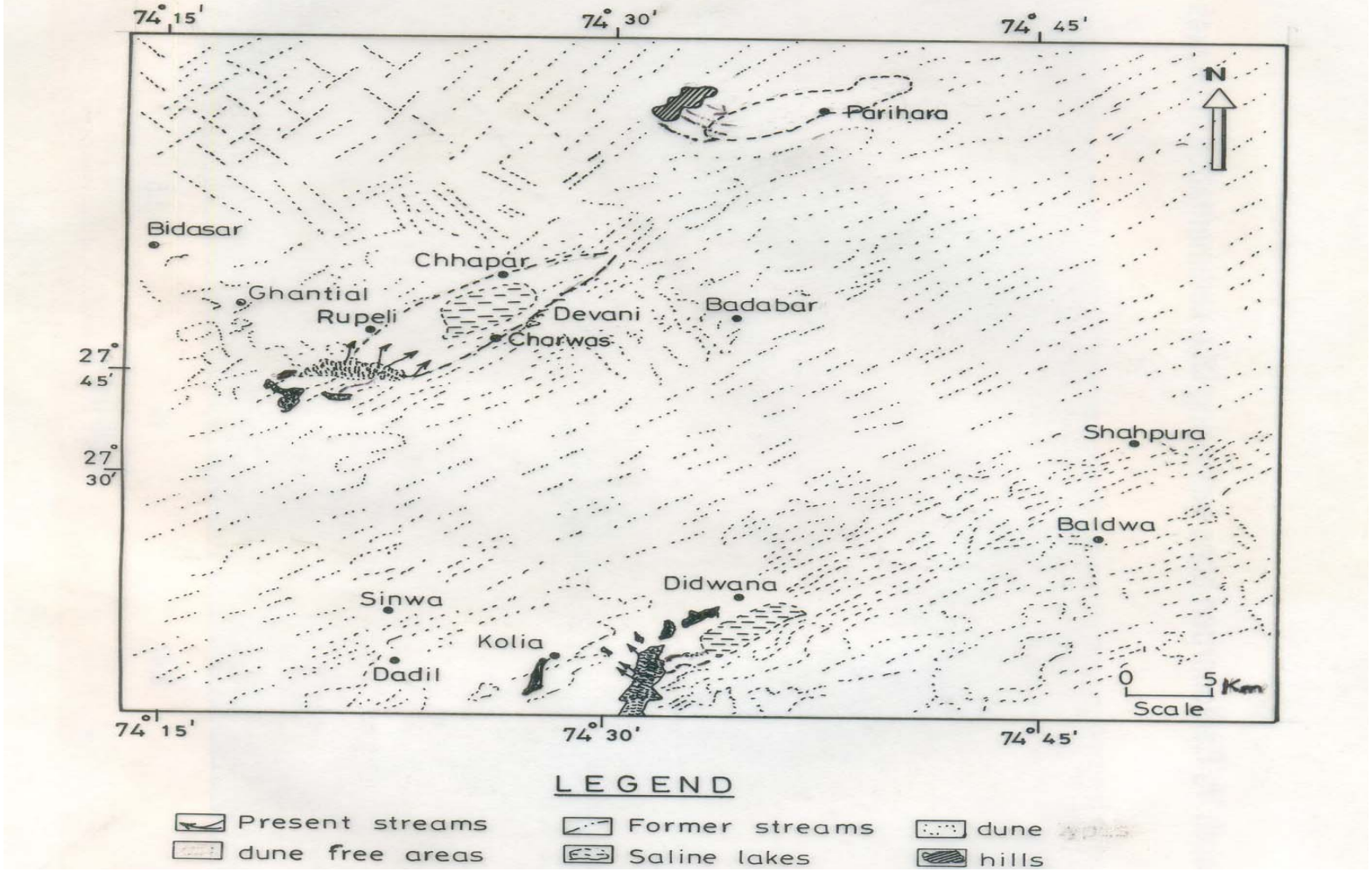
- The central Greenland Ice core (GISP2) background dust concentration also appears to be modulated with a period of 11 years from at least 100,000 years BP. This period coincides with the 11-year Schwabe sunspot cycle .

- Wetter conditions were dated to 4400-4000,1750,1400,1000 and 700 cal BP from peat stratigraphy from three oceanic raised bogs in England and Ireland. Mid-Holocene-an abrupt transition to Sphagnum-rich communities with a monocot rich community indicating dry conditions in Early to Mid Holocene times. (Wiggle match radio carbon dates).


Okara
Pakistan
Jaipur
Hyderabad
Karachi
Ahmadabad
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Google™
Pointer 26°50'56.26" N 71°08'33.94" E
Streaming 100%
Eye alt 566.81 mi


30
28
26
24
70
72
74
76
78
N
INDIA
Lunkaransar Lake
BIKANER
Parihara lake
Talchapar Lake
Didwana lake
Bap/Malar lake
Poheda lake
Kanod lake
JAISALMER
Pokran lake
Dedia lake
Sambhar lake
JODHPUR
Thob lake
Pachpadra Lake
Tilwara
R. Banas
R. Berach
Balathali
Ahar
UDAIPUR
LEGEND
Saline lake
Streams
Archaeological sites
Major cities


PARIHARA
L
H
S
CHHAPAR
L
L
S
L
H
SUJANGARH


74° 15'
74° 30'
74° 45'
N
Parihara
Bidasar
Chhapar
Ghantial
Rupeli
Devani
Charwas
Badabar
27° 45'
27° 30'
Shahpura
Baldwa
Didwana
Sinwa
Kolia
Dadil
0 5 Km
Scale
LEGEND
Present streams
dune free areas
Former streams
Saline lakes
dune
hills

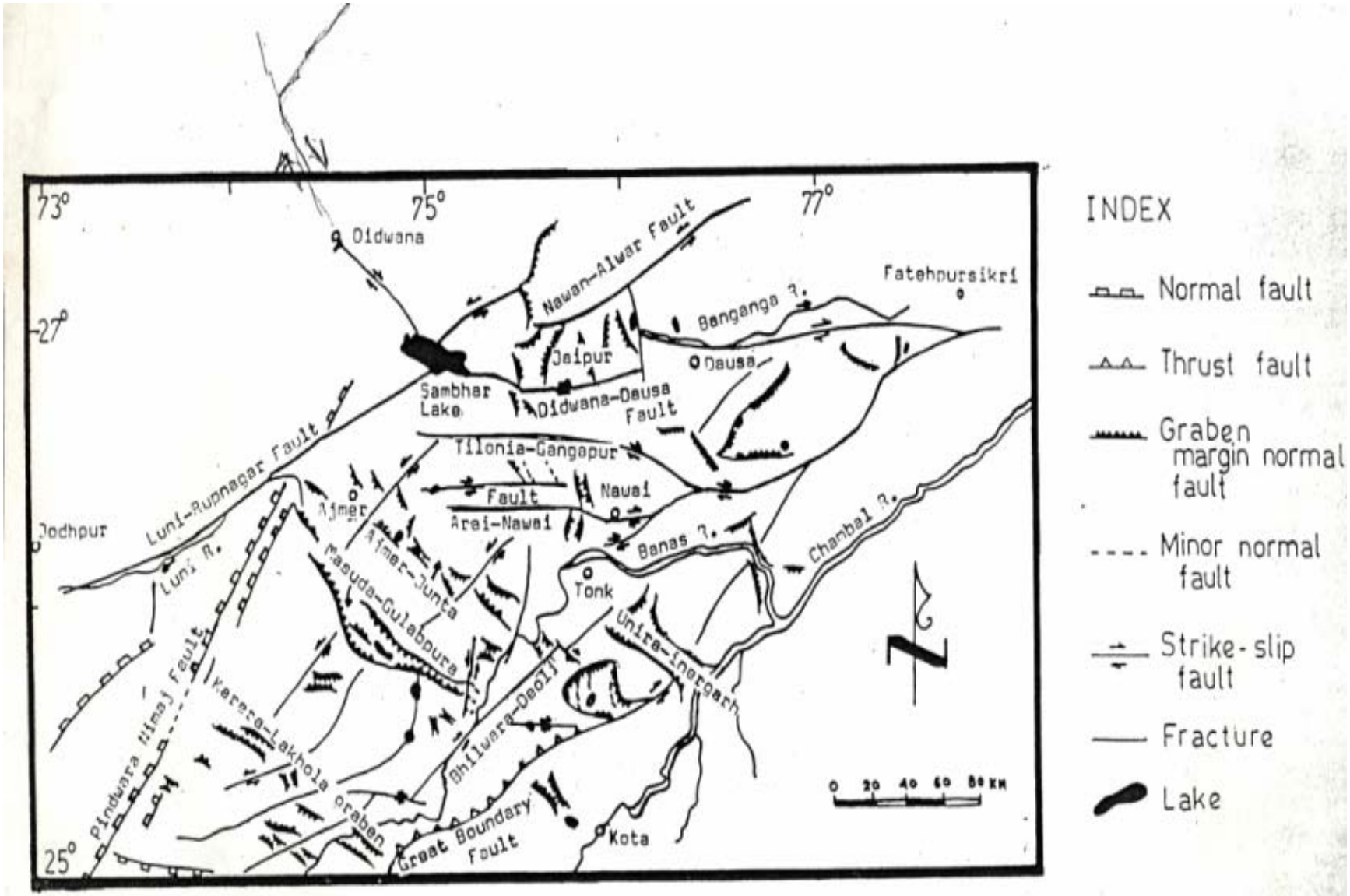


Fig. I.4 Neotectonic features

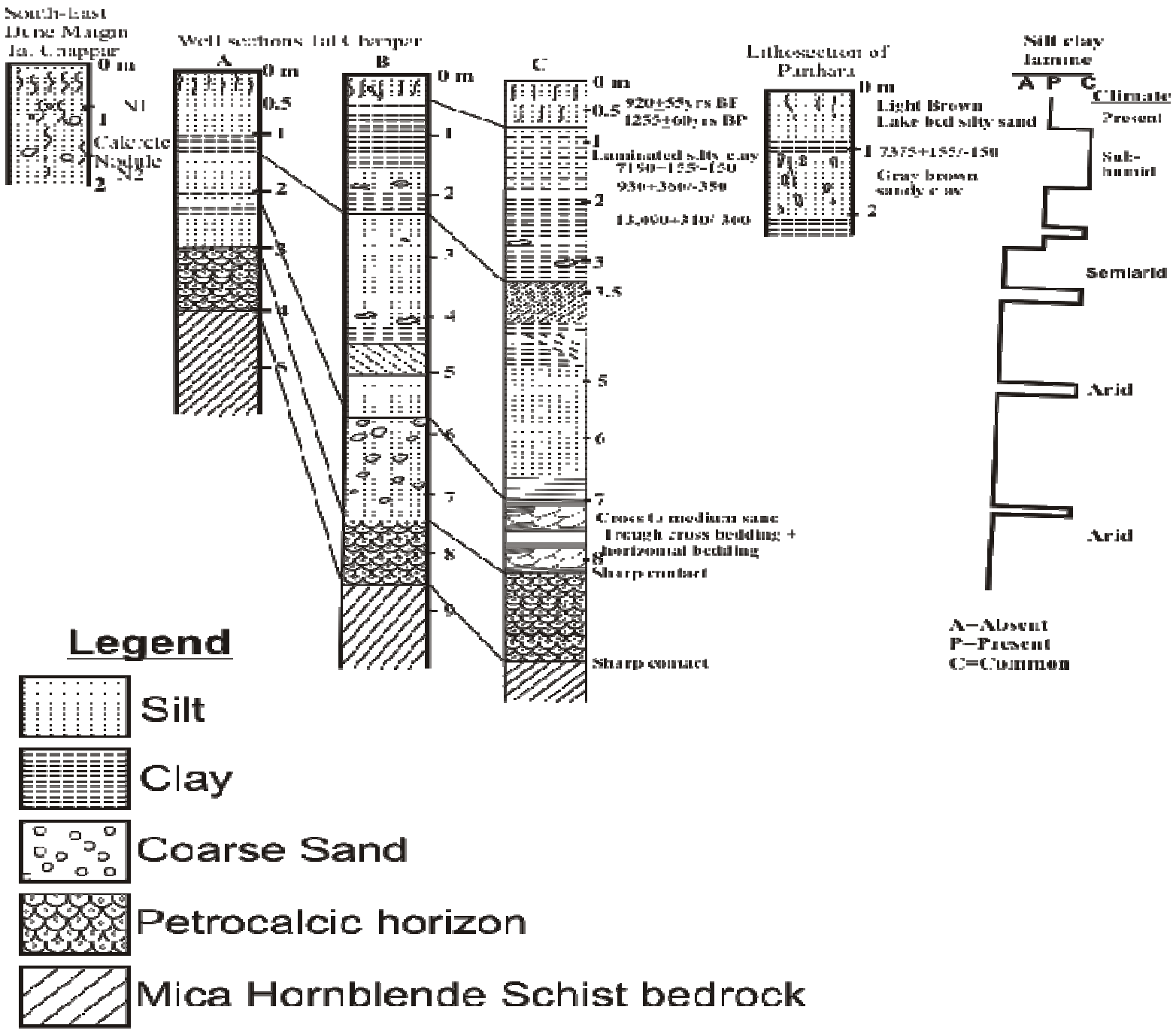
Theories put forward for the origin of the salt lakes

• The salt lakes have been formed by the natural blocking of streams, mainly by dunes e.g., Budha Pushkar, Pachpadra and Degana.

•Erosional depressions and Stream trap hypothesis

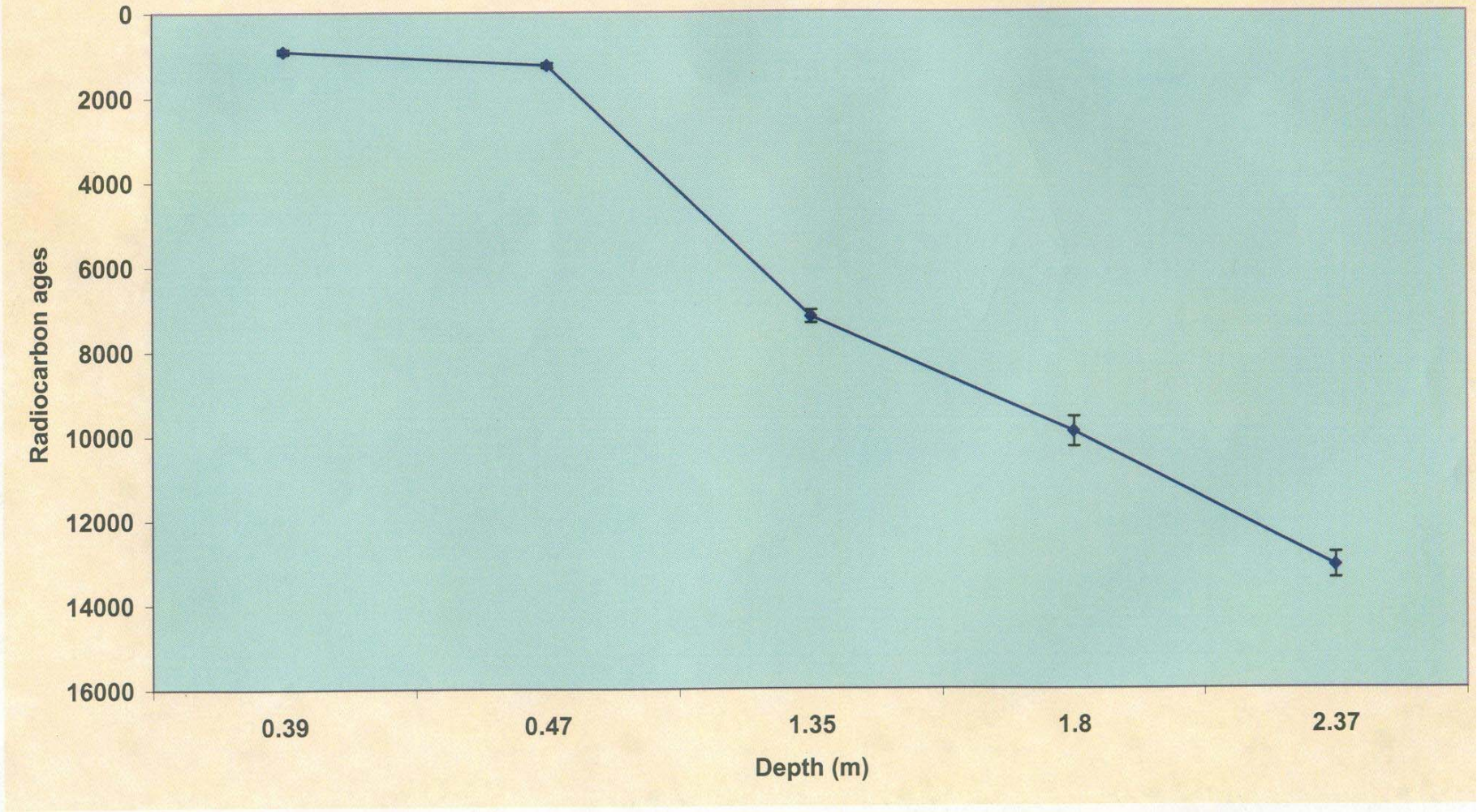
• Formed as a result of faulting and neotectonic activity e.g. Sambhar, Didwana, Talchappar.

•Climate change and depositional environment e.g., Kanod, Bap and lawan


South-East
Dune Margin
Ja. Cuppur
Well sections Tal C. Iyerpur
A
B
C
Lithosection of
Parthara
Silt clay
laminae
A P C
Climate
Present
Sub-
humid
Semiarid
Arid
Arid
Light Brown
Lake bed silty sand
7375+155/-150
Gray brown
sandy c ay
920±55yrs BP
1252±60yrs BP
Laminated s.lty c.ay
7150−125/-150
930+360/-350
13,000+310/-300
Cross b medium sand
Trough cross bedding +
horizontal bedding
Sharp contact
Sharp contact
A=Absent
P=Present
C=Common
Legend
Silt
Clay
Coarse Sand
Petrocalcic horizon
Mica Hornblende Schist bedrock

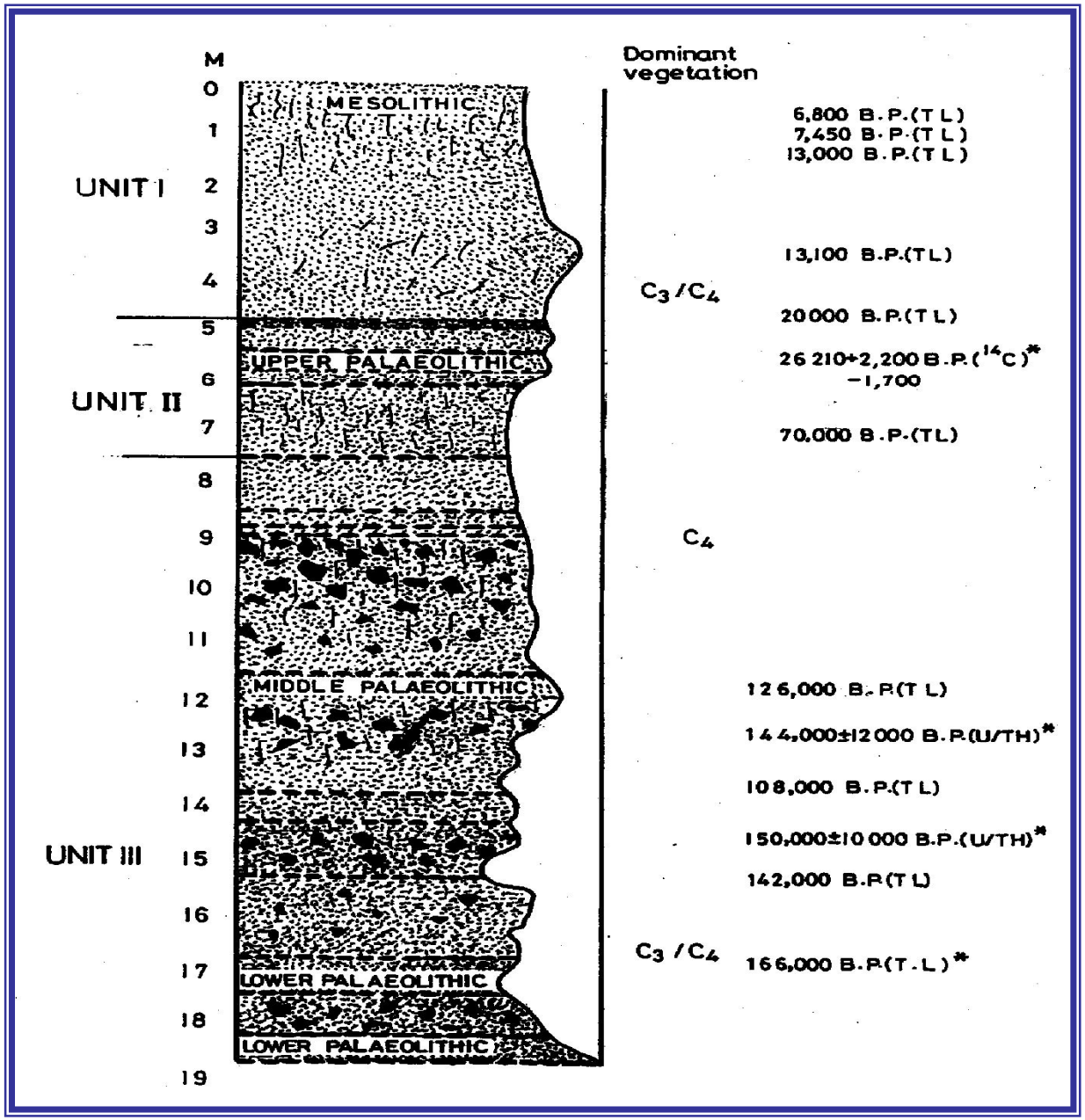
Depth in m.	Calibrated age	Radiocarbon ages
0.39	1016 to 1232 AD	920±55
0.47	662 to 892 AD	1255±60
1.35	6307 to 5800 BC	7190±155
1.7	5100 to 5340 BC	6620±170
1.8	10525 to 8300 BC	9930±360
2.37	14450 to 12700 BC	13090±310

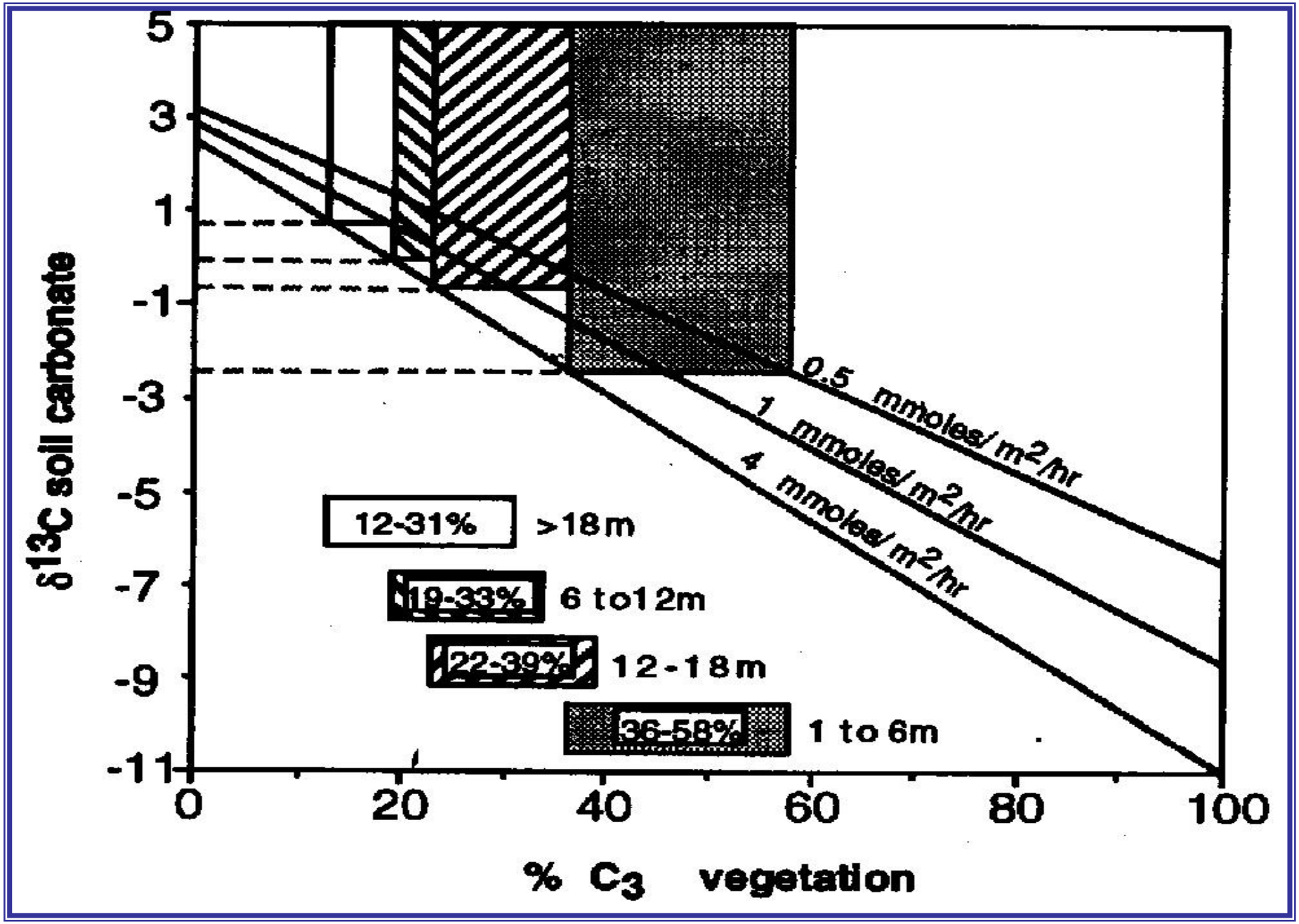
Fig. 3 Depth Vs Radiocarbon ages indicating lake sedimentation in phases

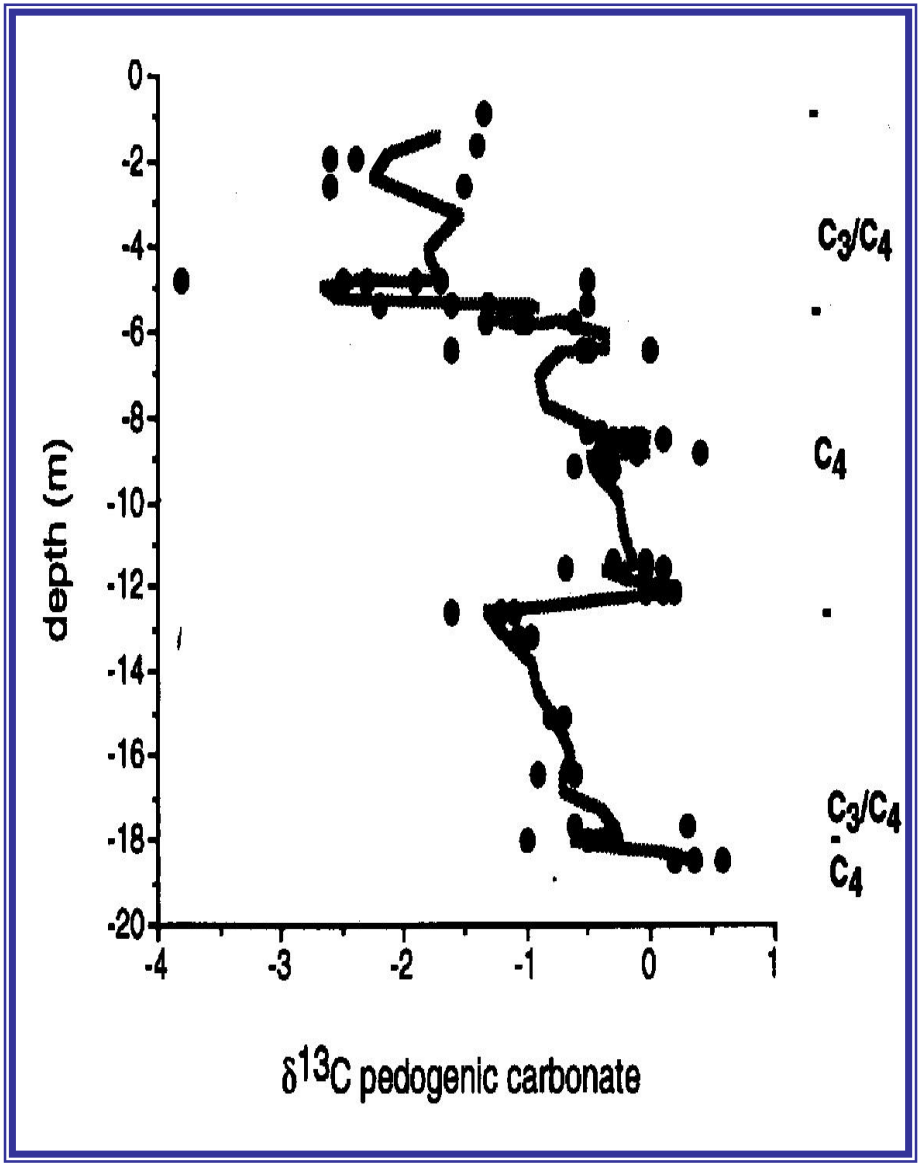


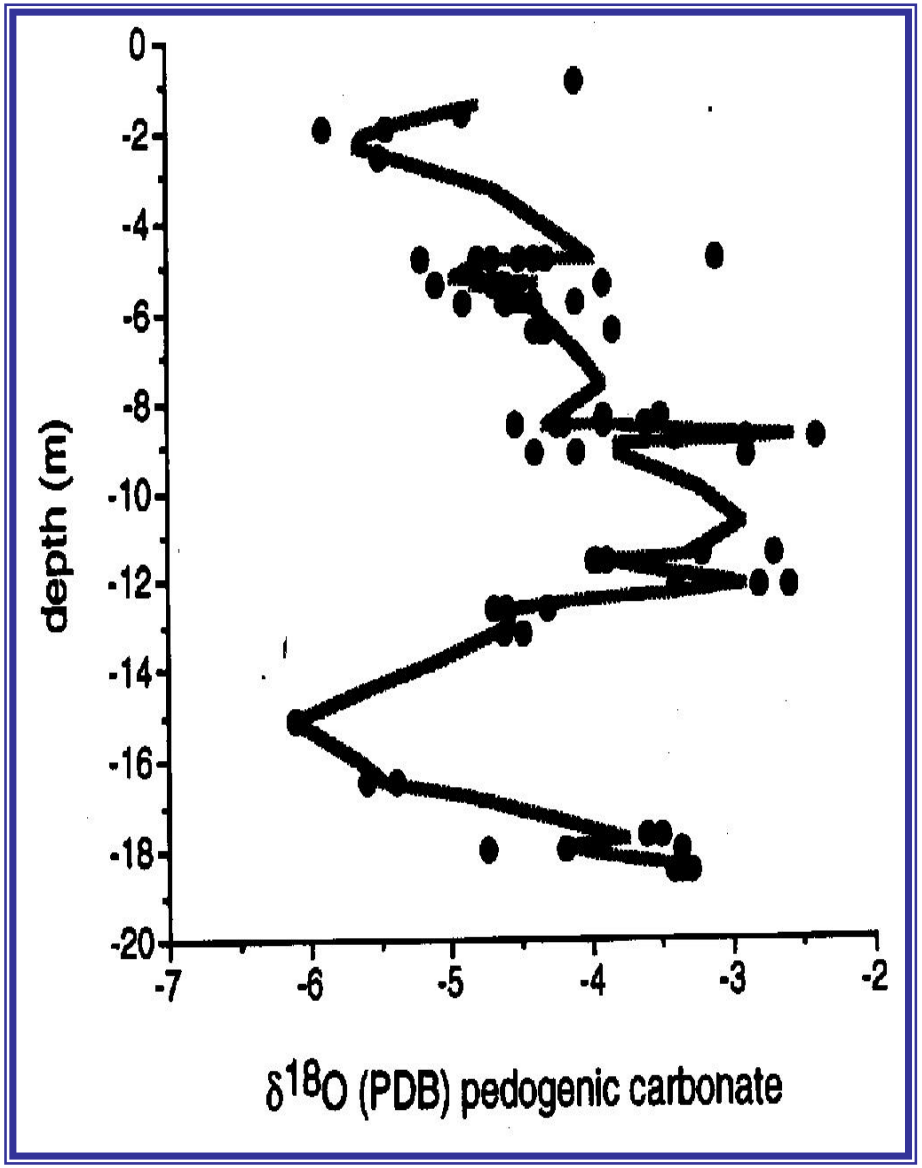
CARBON isotopes from soil carbonate and soil organic matter yield palaeoecological information because the carbon in the soil carbonate forms in isotopic equilibrium with local soil CO_2 the isotopic composition of which is in turn determined by local plant cover.

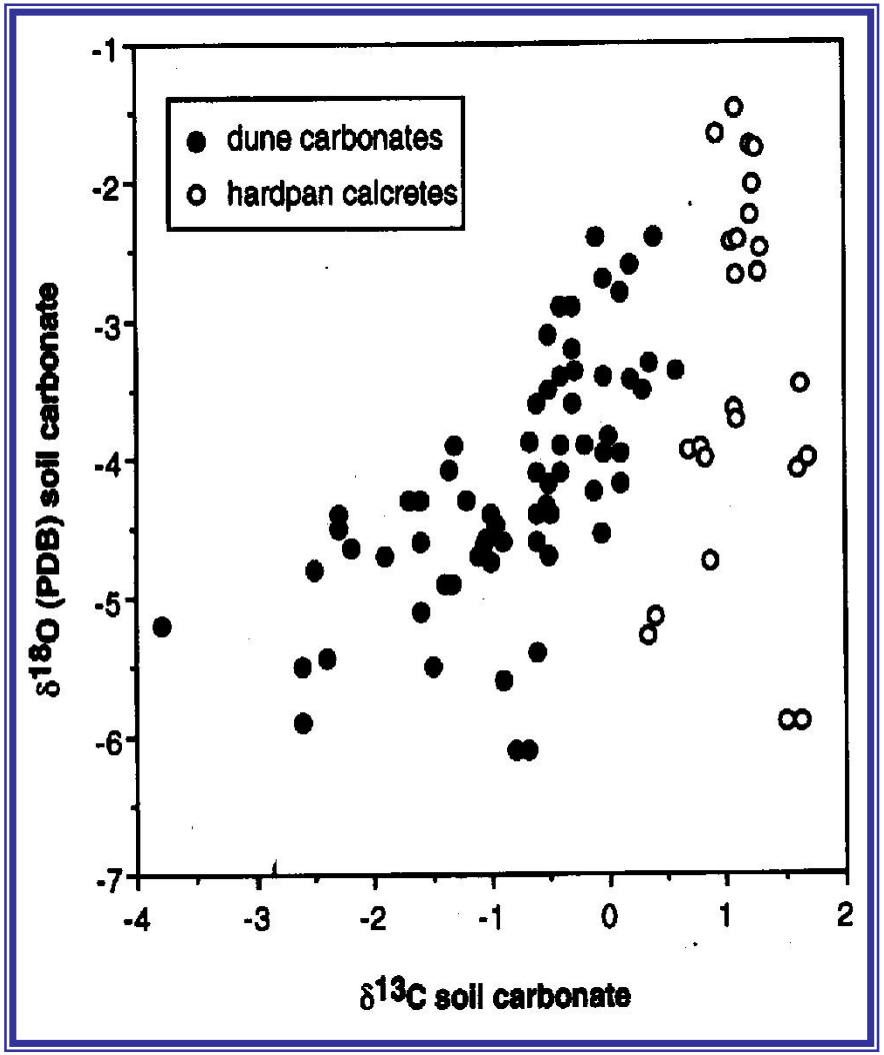
Photosynthetic path way C3 and C4, CAM plants.


M
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
UNIT I
UNIT II
UNIT III
MESOLITHIC
UPPER PALAEOLITHIC
MIDDLE PALAEOLITHIC
LOWER PALAEOLITHIC
LOWER PALAEOLITHIC
Dominant vegetation
6,800 B.P.(TL)
7,450 B.P.(TL)
13,000 B.P.(TL)
13,100 B.P.(TL)
C3/C4
20000 B.P.(TL)
26210+2,200 B.P.(14C)*
−1,700
70,000 B.P.(TL)
C4
126,000 B.P.(TL)
144,000±12000 B.P.(U/TH)*
108,000 B.P.(TL)
150,000±10000 B.P.(U/TH)*
142,000 B.P.(TL)
C3/C4
166,000 B.P.(TL)*


5
3
1
-1
-3
-5
-7
-9
-11
0
20
40
60
80
100
δ13C soil carbonate
% C3 vegetation
0.5 mmoles/m2/hr
1 mmoles/m2/hr
4 mmoles/m2/hr
12-31%
>18m
19-33%
6 to12m
22-39%
12-18m
36-58%
1 to 6m


depth (m)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-4
-3
-2
-1
0
1
C3/C4
C4
C3/C4
C4
δ13C pedogenic carbonate


depth (m)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-7
-6
-5
-4
-3
-2
δ18O (PDB) pedogenic carbonate


dune carbonates
hardpan calcretes
δ18O (PDB) soil carbonate
δ13C soil carbonate
-1
-2
-3
-4
-5
-6
-7
-4
-3
-2
-1
0
1
2

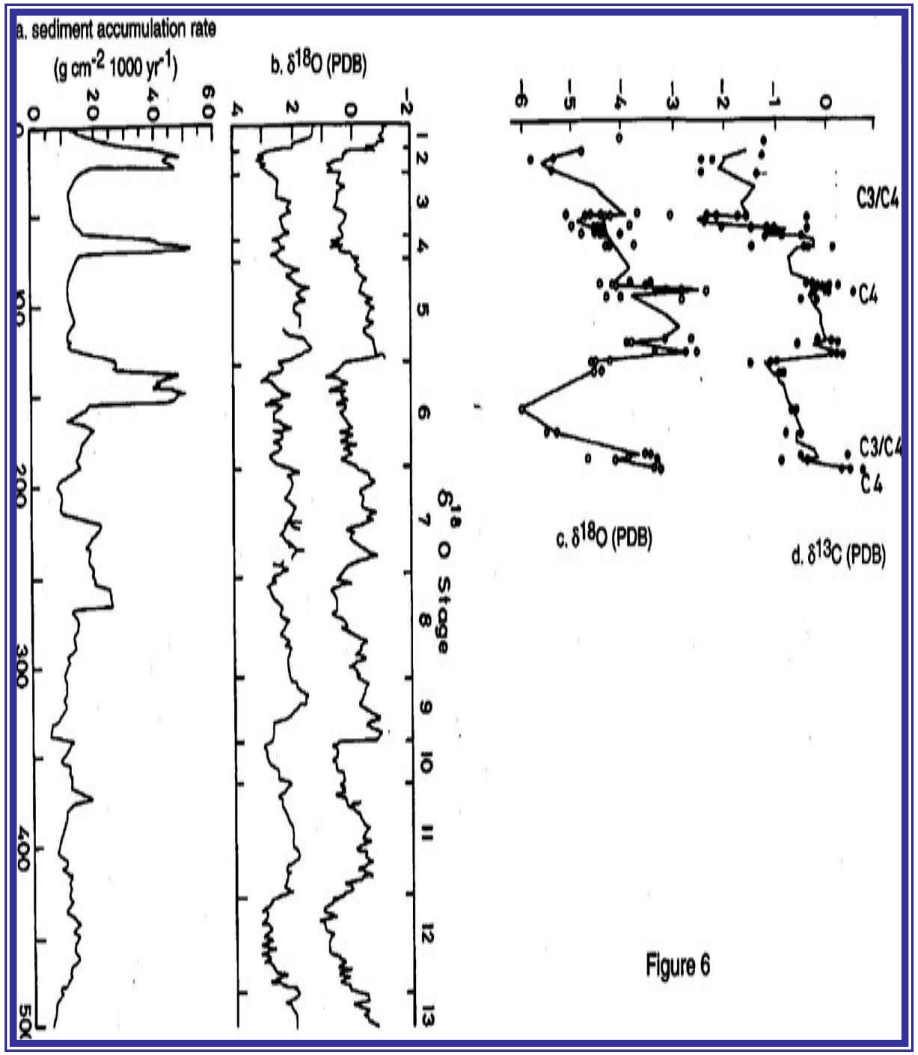

a. sediment accumulation rate
(g cm-2 1000 yr-1)
b. δ18O (PDB)
δ18 O Stage
c. δ18O (PDB)
d. δ13C (PDB)
C3/C4
C4
C3/C4
C4

Figure 6


Okara
Pakistan
Jaipur
Hyderabad
Karachi
Ahmadabad
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Google™
Pointer 26°50'56.26" N 71°08'33.94" E
Streaming 100%
Eye alt 566.81 mi

Siwalik soils

Siwalik Group sediments in northern Pakistan contain a well exposed palaeosol record spanning the past 18 Myr.

Stable-carbon-isotope results from associated pedogenic carbonate indicate a dramatic ecological shift from C_3- to C_4-dominated floodplain biomass beginning 7.4−7.0 Myr ago.

The earlier C3 floodplain biomasses were probably mainly composed of trees and shrubs, whereas C4 grasslands dominated in the Plio-Pleistocene. Oxygen isotopes also exhibit a shift in the latest Miocene, probably corresponding to a major climate change which may have induced the forest-to-grassland transition. This dramatic ecological shift in the latest Miocene mark the inception or a marked strengthening of the Asian monsoon system.

Conclusions

- Palaeoenvironmental reconstruction enabled identification of a more humid phase during the Mid Holocene based on the salt lake litho profiles, but a unstable phase between 13,000 to 7,000-6500 yrs BP. This was the phase when both the south west monsoon were becoming reestablished and the younger dryas occurred.

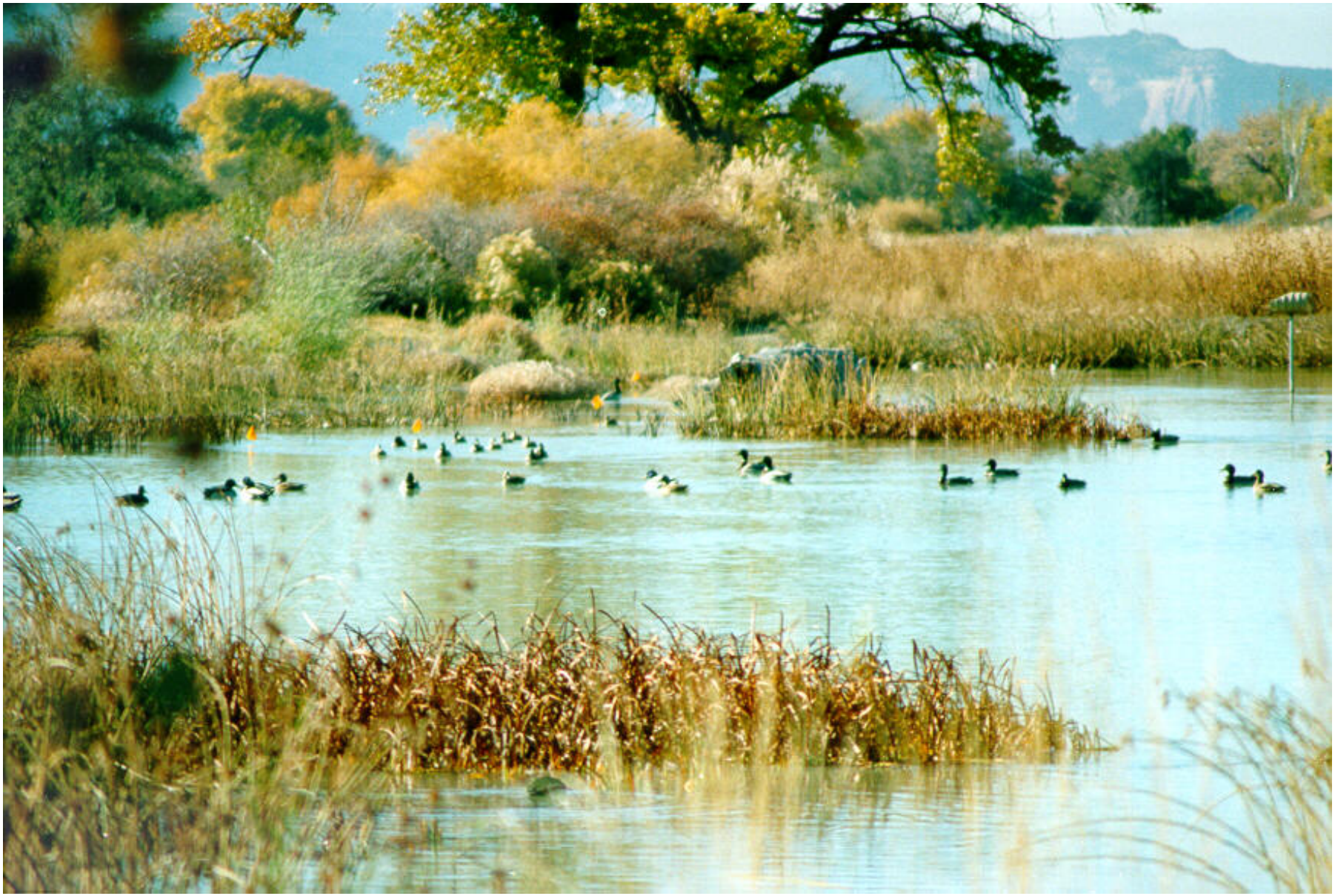
The lakes covered large area during the last glacial maximum but shrunk subsequently adjusting to the varying hydrological regime and paleoclimate change.

The dry lake beds and the periphery of the lakes were sandy and were the major sources of sand forming series of dunes bordering the lakes thus reducing the spatial coverage of the lakes. The lacustral saline facies and aeolian sediment facies could have been deposited only during arid to semi aridity since ~14,000 yrs BP.
Mid Holocene to Late Holocene period was dry, probably windy with weak monsoon circulation.

$\delta^{13}C$ and δ18O values of carbonates

➢**Carbonates have a lower $\delta^{18}O$ value because the $\delta^{18}O$ values of the waters that are responsible for their precipitation are meteoric and less.**

➢ **$\delta^{18}O$** values can be correlated to the oxygen isotope stage 3 and stage 5-climate being predominantly semi arid.



Thank you