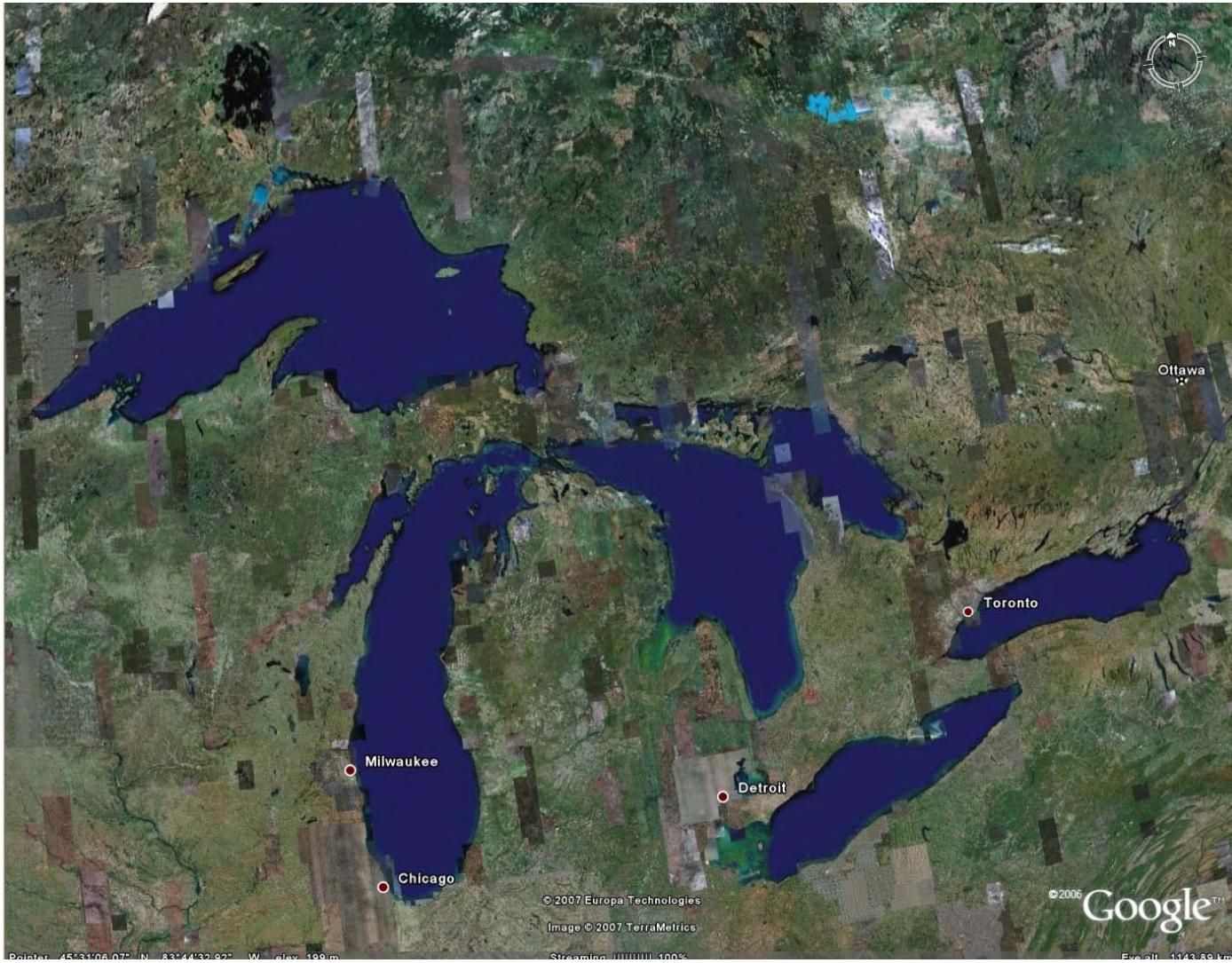


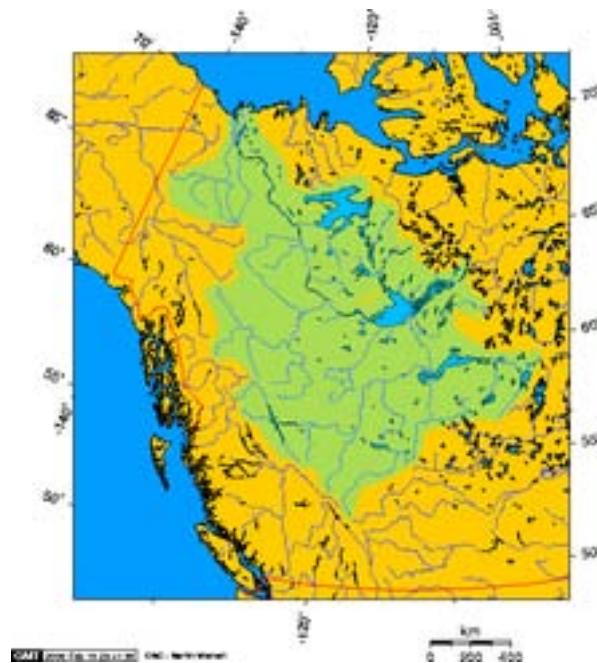
Lacustrine systems

The Great Lakes



Great Bear Lake

- Great Bear Lake is the 7th largest lake in the world (31,000 km²)
 - Maximum depth is 446 m (average: 71 m)
 - Part of the Mackenzie River drainage system
 - Formed in preglacial valleys reshaped by glacial erosion
 - Drainage affected by postglacial rebound
 - Canadian Shield on the eastern margin
 - Interior Plains on the western side
- A polar lake although in a northern continental setting



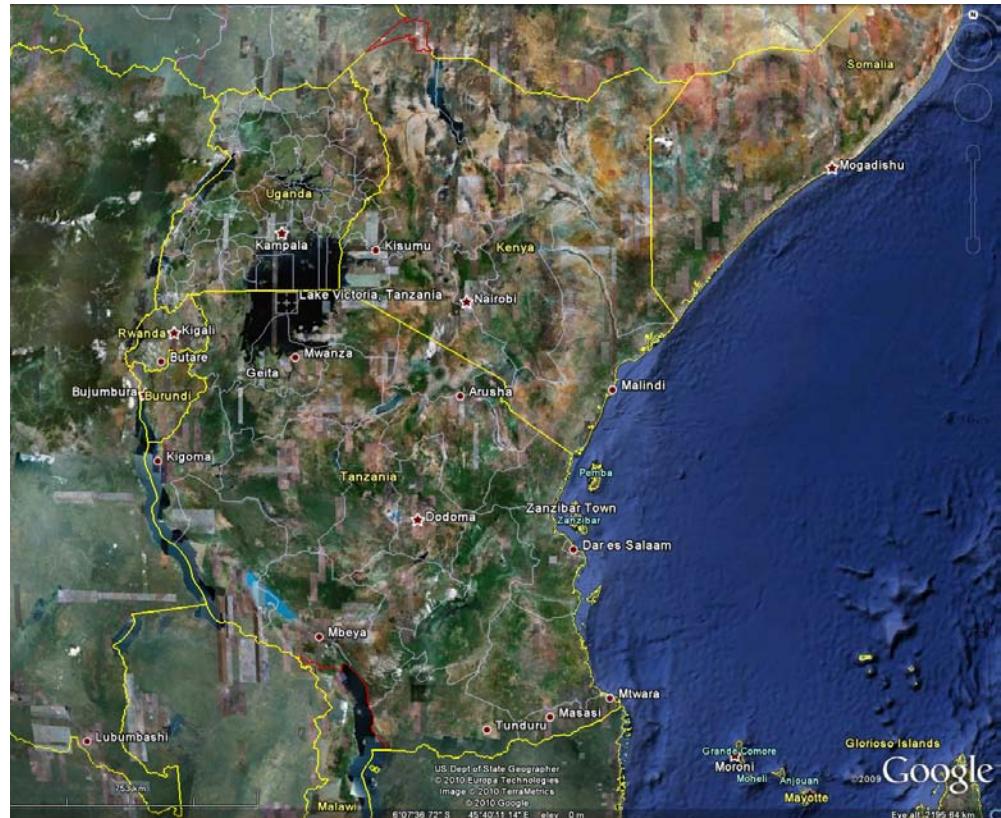
Lake Winnipeg

- **Lake Winnipeg** is a very large (about 24,000 km²) lake in central North America, in the province of Manitoba, Canada
 - Sixth-largest freshwater lake in Canada,
 - relatively shallow (mean depth of 12 m (39 ft) excluding a narrow 36 m (118 ft) deep channel between the northern and southern basins.
 - It is the 10th-largest freshwater lake on Earth.



Tropical lakes

- Lake Victoria is Africa's largest lake
 - Largest tropical lake in the world
 - Receives most of its water from direct precipitation
 - The largest influent is coming from the west
 - Only one river effluent (the White Nile) is located on the north shore
- Lacustrine sequences show that the lake has dried up completely three times since it formed.
 - These drying cycles are probably related to past ice ages,
 - Times when precipitation declined globally.
 - The lake last dried out during the last glaciation (approx. 17 ka BP), and filled again during global deglaciation.
 - The lake is relatively young (about 400 ka old)



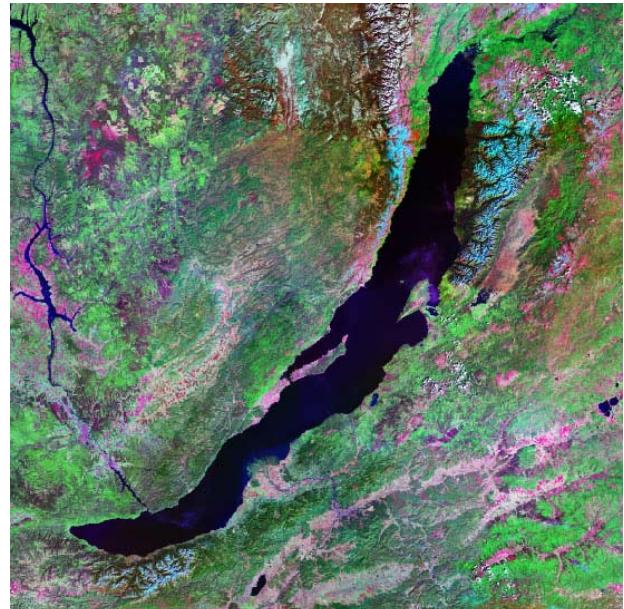
Rift lakes

- Lake Tanganyika is the second deepest lake... (mean = 570 m; max. 1,470 m)
 - Western African Rift
 - Great depth and tropical location
 - No turnover of water masses
 - Stratification of water masses
 - » Deep waters are “fossil-water”
 - » Anoxic (no oxygen)
 - Two rivers are flowing into the lake, and numerous smaller rivers and streams



Rift lakes

- Lake Baikal: 636 km long and 80 km wide; 1637 m deep!
- 20% of the world's surface fresh water.
- At 1,642 m a.s.l.
- Also oldest lake (>25 Ma)!
- Ancient rift valley
- Its sediments have not been scoured by overriding continental ice sheets.
 - Sediment cores provide a detailed record of climatic variation over the past 250,000 years.
- The lake is fed by as many as three hundred and thirty inflowing rivers
 - Well-mixed and oxygenated



Impact craters (lakes)



Lac à l'Eau Claire



Pingaluit crater

2.8 km
Water depth = 267 m



Salt lakes



Brackish water lakes: 1-5 g/l of diss. const.
Salt lakes: > 5 g/l

Caldera and other volcano crater lakes

53 km² and up to 580 m deep

Crater Lake, Oregon



Volcán Irazú, Costa Rica

A volcanic lake is a cap of meteoric water over the vent of an active volcano.

"**Hot Acid-Hyperbrine**" volcanic lakes (large volcanic/geothermal input)

"**Acid-Brine**" lakes are those that exhibit near perfect mixing

"**Acid-Saline**" lakes have stable buoyant jets

"**Acid-Sulfate**" and "**Bicarbonate**" lakes receive even less energy and may have buoyant plumes or be stably stratified.

"**Neutral-Dilute**" volcanic lakes have no volcanic input and are thus hazard-free



The Subglacial Lake Vostok System

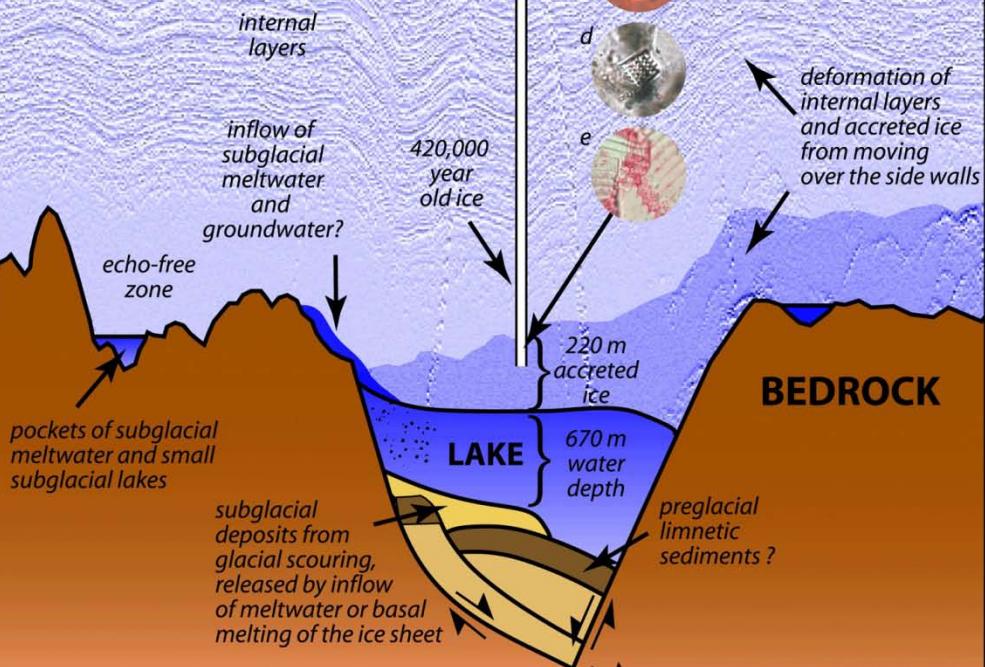


AIR

ice flow
from
Ridge B

Vostok Station
cored
3623 m

ICE SHEET



© 2001, M. Studinger and R.E. Bell,
Lamont-Doherty Earth Observatory

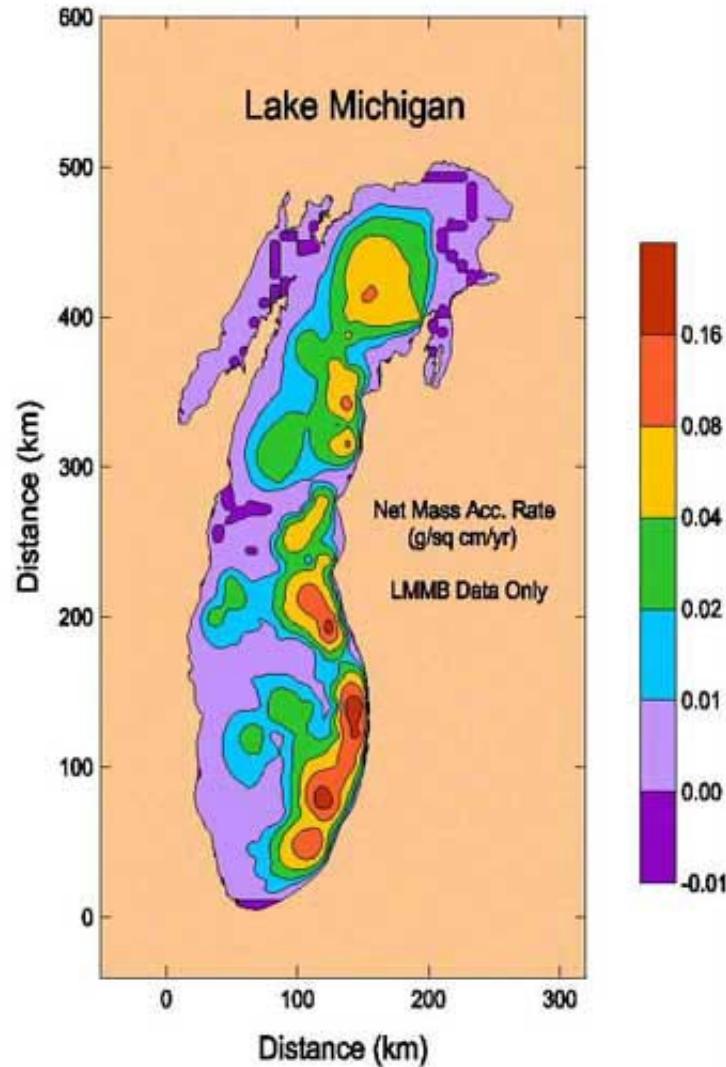
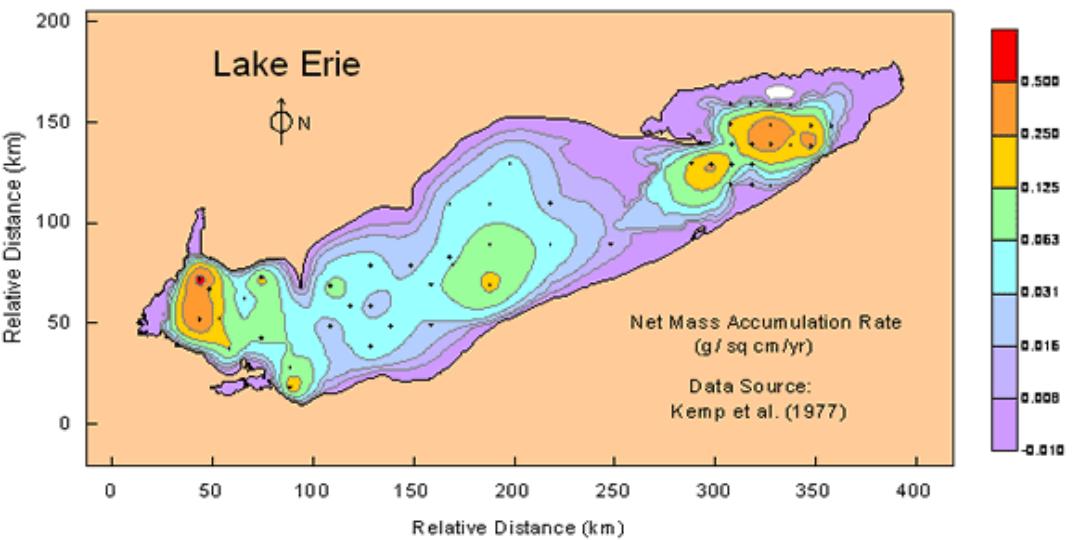
Bacteria are from J. Priscu (a) and D. Karl (b). Pollen, marine diatoms and unknown biogenic material are from L. Burckle and R. Sambrano, LDEO, (c-e).

SR in lacustrine environments

- SR in lakes display a very wide range depending on the size of the lakes and the characteristics of their drainage areas
 - Clastic seds. of small to middle-sized lakes
 - 100 to 1000 cm/ka
 - Carbonates
 - 10 to 100 cm/ka
- Lacustrine and marine evaporites can be precipitated at extremely high rates (50 m/ka)
- Vertical growth of peat can be fast
 - Holocene peats in temperate and tropical regions have accumulated at rates up to 2 m/ka
 - SR for compacted Paleozoic to Cenozoic coals in France, China, Germany, and Africa vary between 0.3 and 30 cm/ka

Examples of recent AR

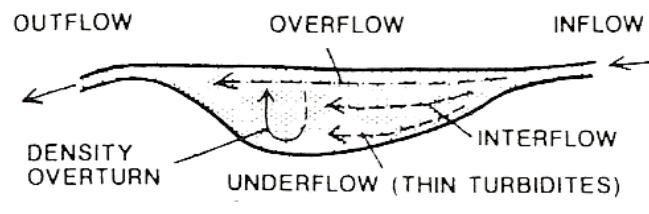
AR: Accumulation rates ($\text{MA}^{-1}\text{T}^{-1}$)



Source: NOAA

“Open” lake systems

a “OPEN” LAKE SYSTEMS

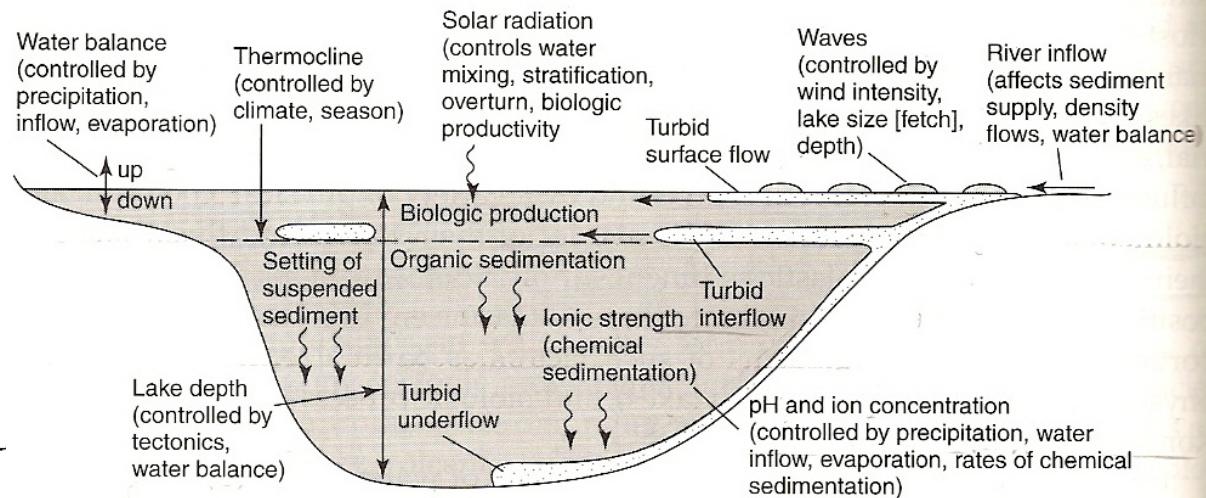


WATER FRESH OR SLIGHTLY BRACKISH,
RIVER-DOMINATED CLASTIC SEDIMENTS.
TENDENCY TO:

a₁ OLIGOTROPH (deep lake) LITTLE NUTRIENTS

NO PERMANENT STRATIFICATION BOTTOM LIFE
WELL OXYGENATED

ANNUAL VARVES OR POOR LAMINATION,
LITTLE ORG. MATTER, PARTLY IRON HYDROXIDES, TURBIDITES



a₂ Stratified lakes with eutrophic conditions (shallow and deep lakes)

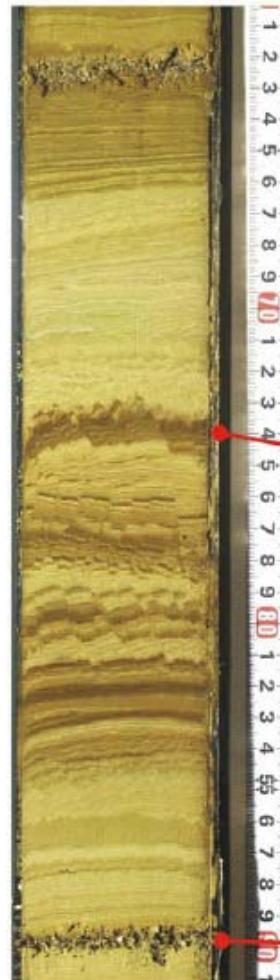
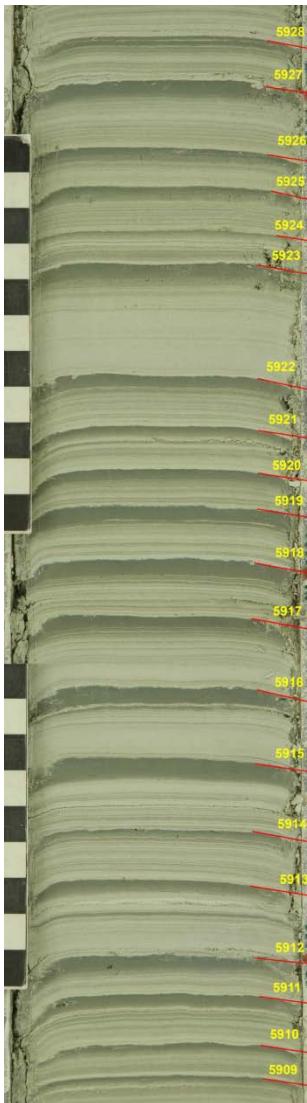
EPILIMNION (WELL OXYGENATED)
MESOLIMNION
HYPOLIMNION, OXYGEN MINIMUM ZONE
DISTINCT LAMINATION, RICH IN ORG. MATTER, ± SIDERITE CONCRETIONS

± STABLE STRATIFICATION
BOTTOM LIFE SPARSE OR ABSENT

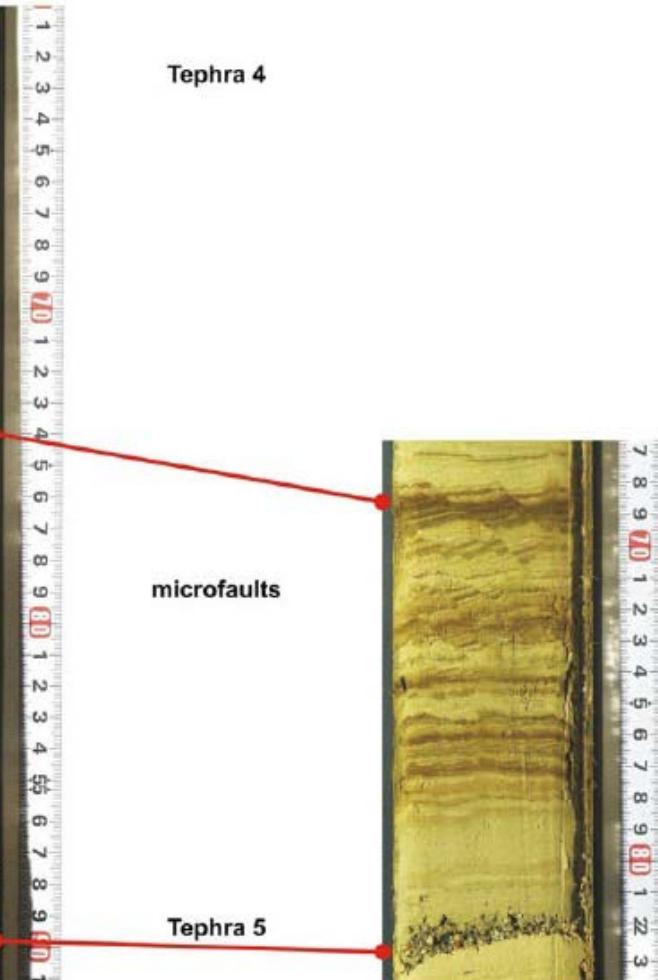
Abundant dissolved nutrients

Seasonal

Laminated lake sediment



Van04-2



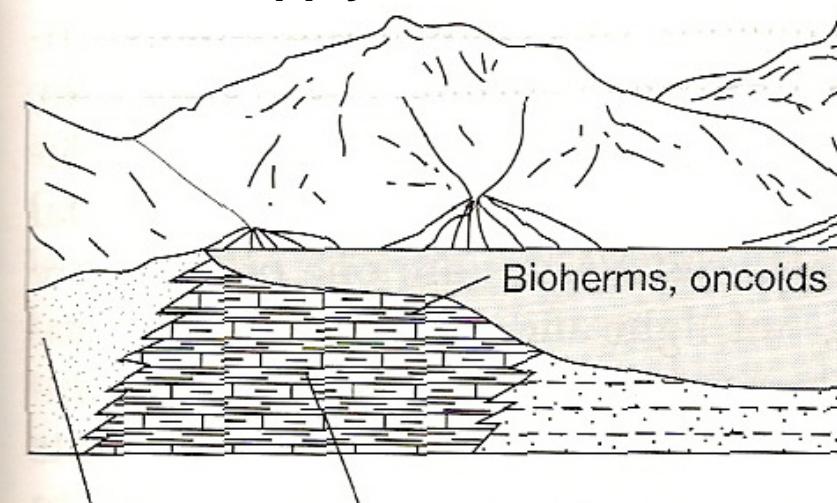
Van04-7

Laminated lake sediment

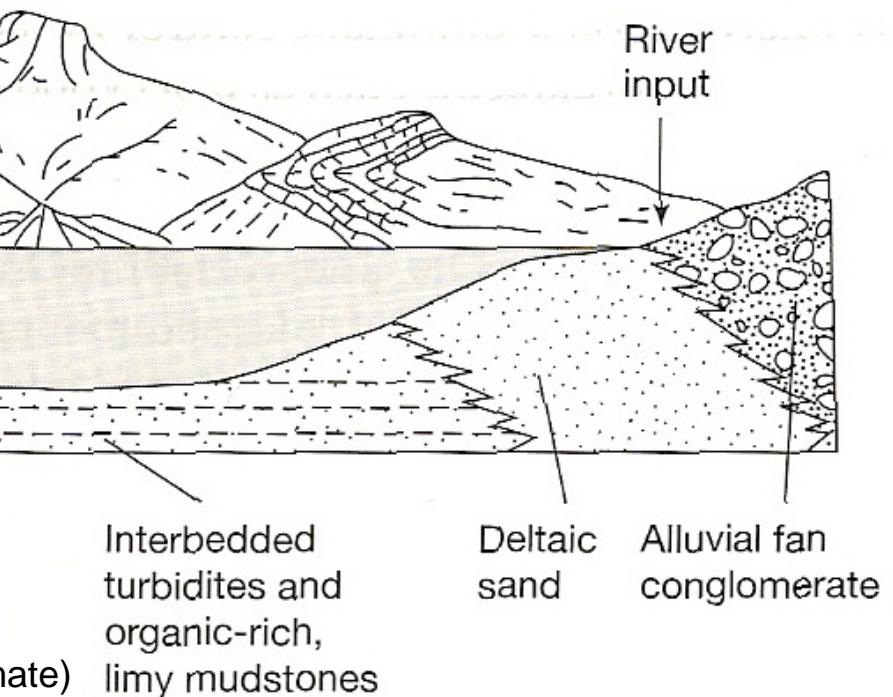


Sediment types in “open” lakes

Low sed. supply



High sed. supply

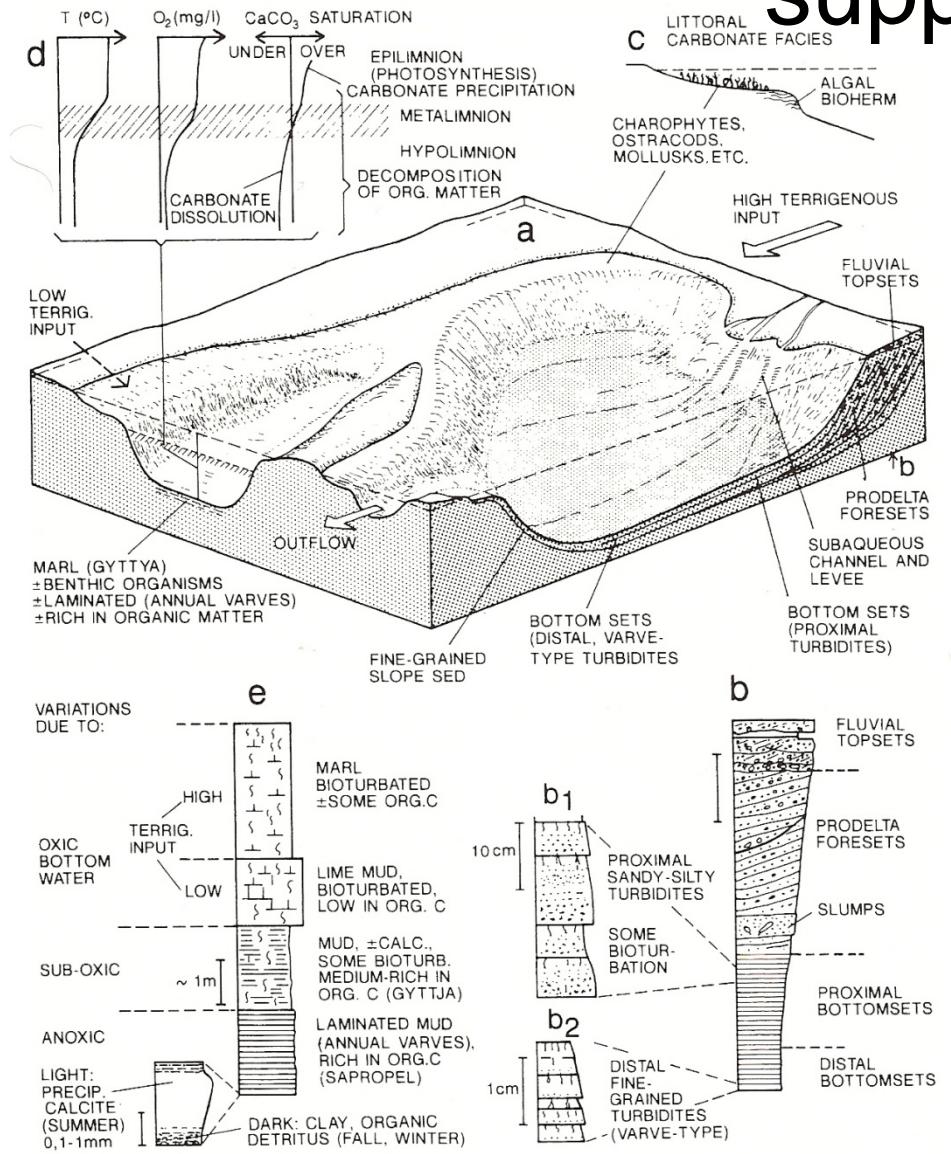


Bioherm: Moundlike or reeflike mass of rock built by sedentary organisms

Oncoids: Small stromatolite (< 10 cm in diameter)

Charophyte: One of a group of green algae

“Open” lake systems with high sed. supply

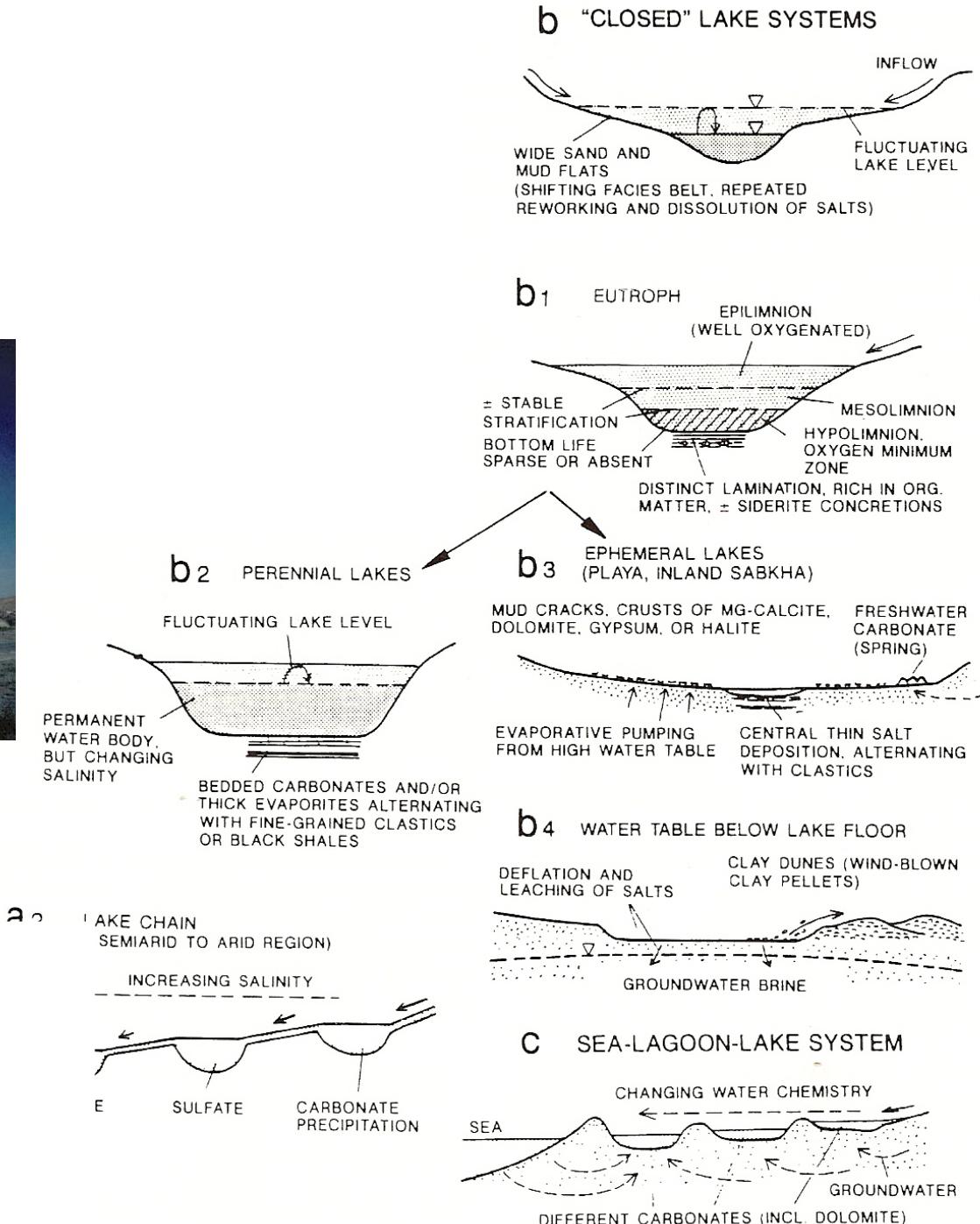


Prodelta area: 10s – 100s m/ka

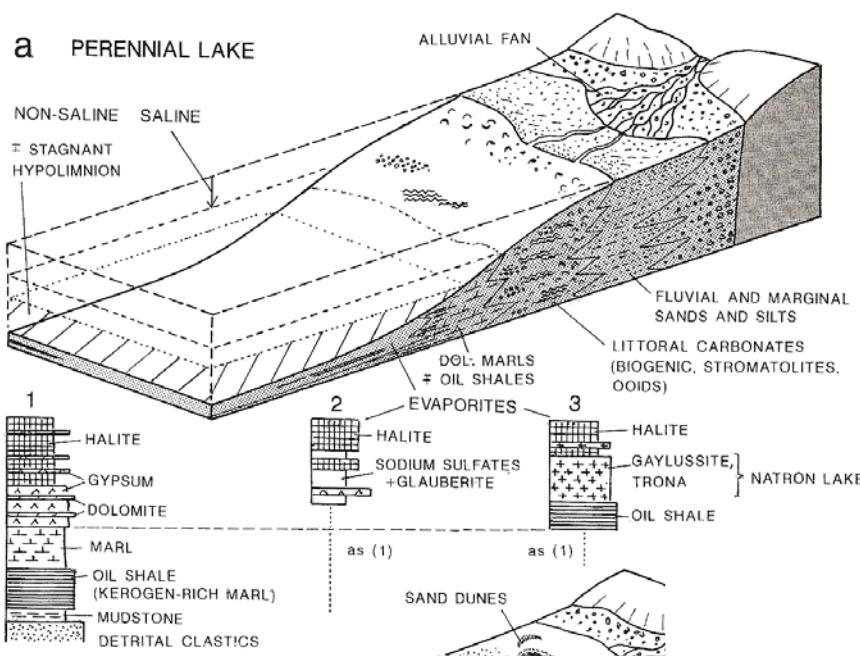
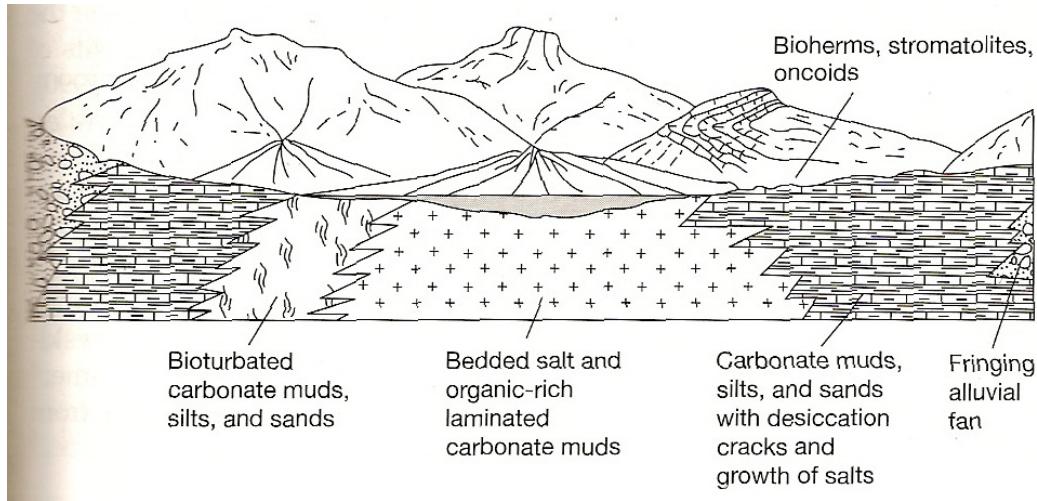
Lake center: 3 – 10 m/ka

Lake slopes: 1 – 3 m/ka

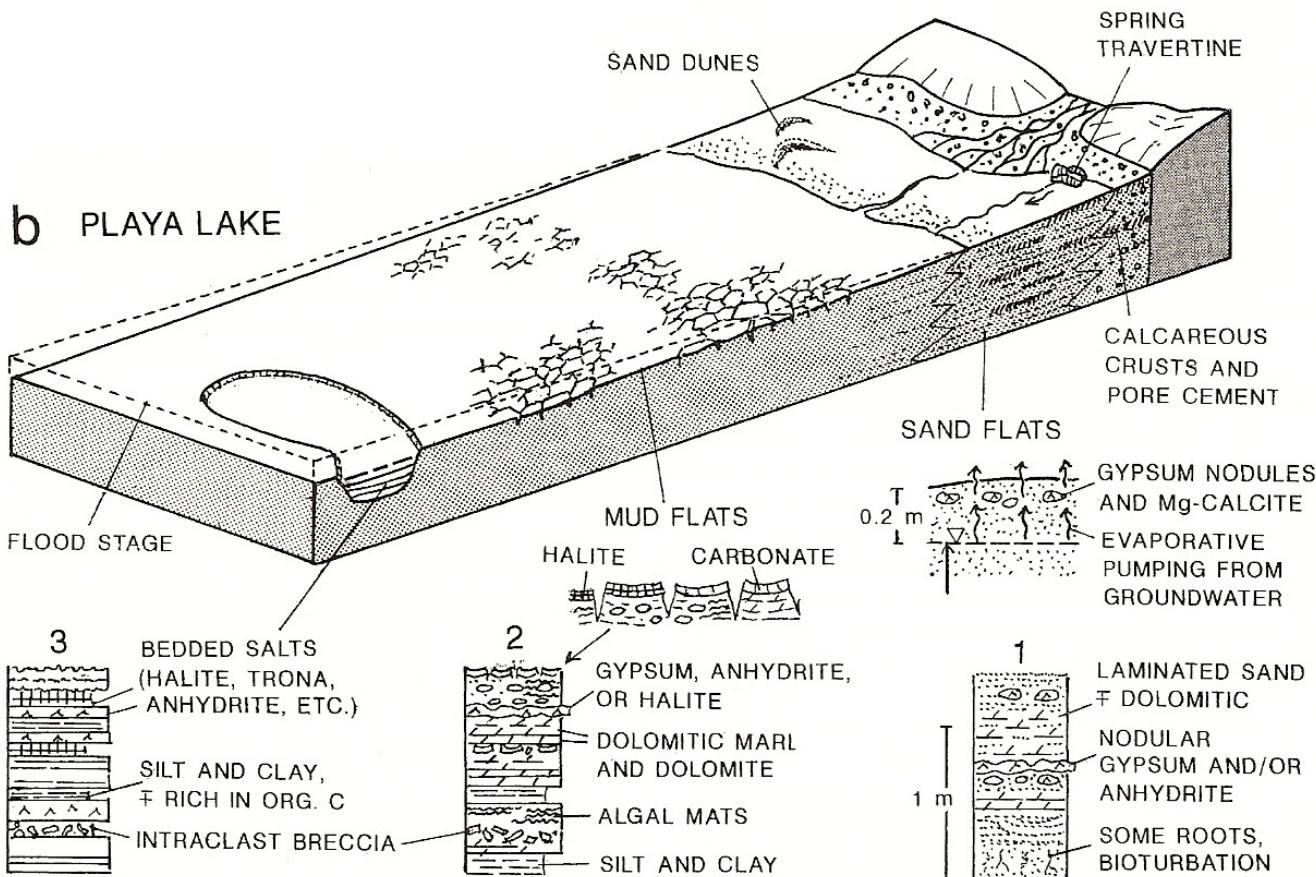
“Closed” lake systems



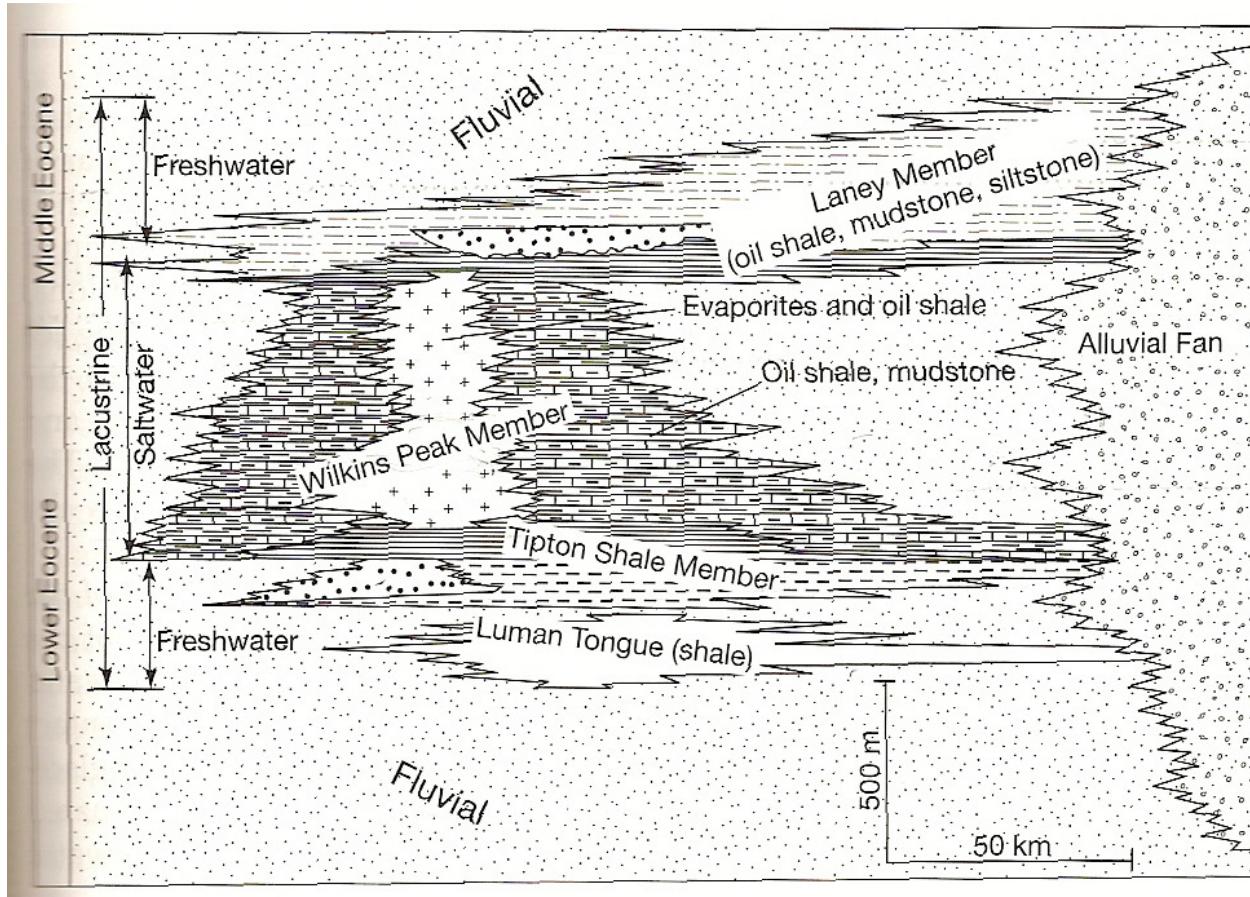
Perennial saline lake basin



Playa lakes



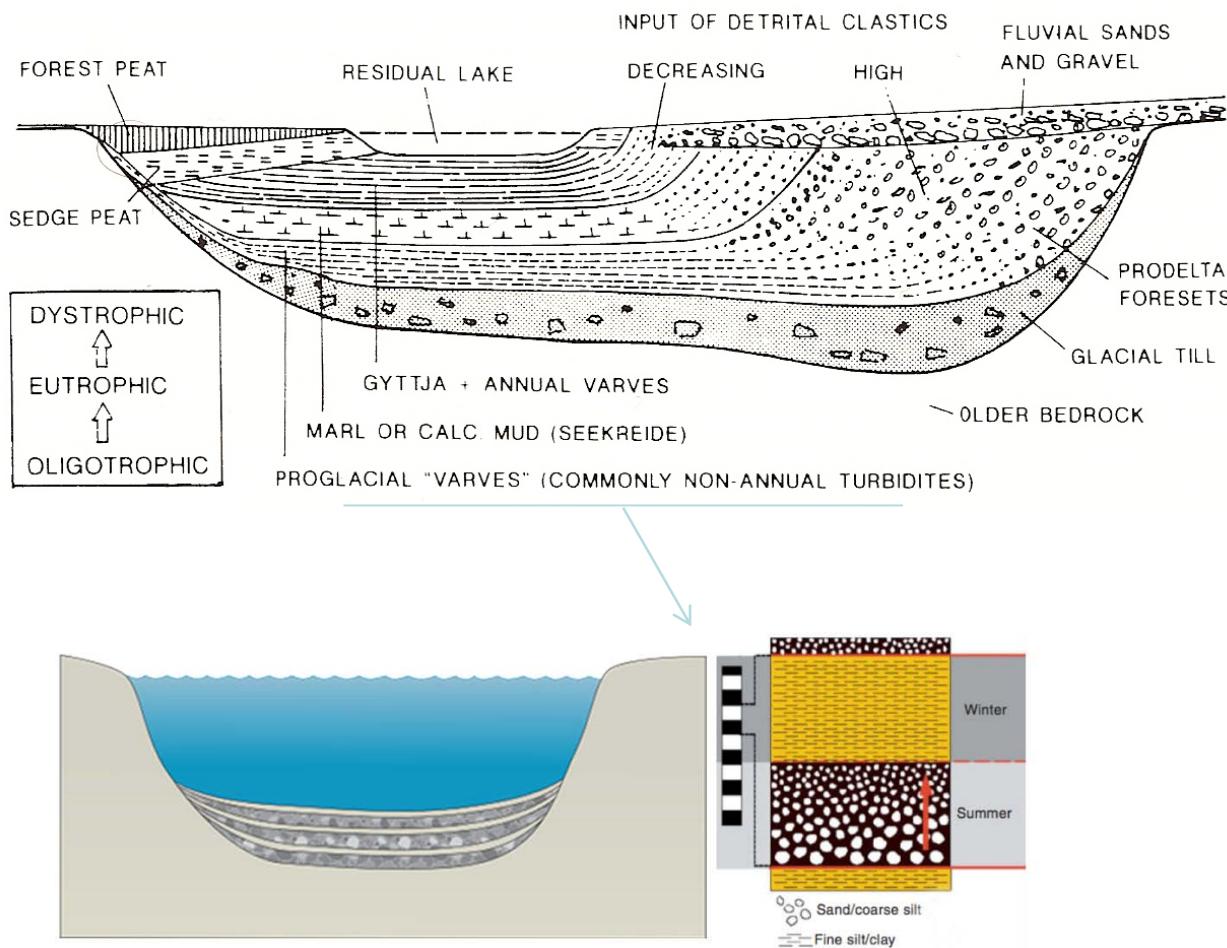
Ancient lake deposits



- Freshwater carbonates
- Thin dolomitic beds
- Iron oxides or siderite concretions
- Oil shales
- Evaporites
- May be interbedded with fluvial seds. and fossil soils (paleosols)

Eocene Green River Formation, Wyoming

Post-glacial evolution of a small lake



Summary (lacustrine systems)

- Sedimentary processes in lakes are very sensitive to climate change
- Sediments of open lakes are dominated by
 - detrital clastics
 - Biogenic carbonates and/or silica
- Closed lakes precipitate evaporites and abiotic chert
- The peak of arid phases may be reflected by
 - Inland sabkhas
 - Dryed mudflats and paleosols
- Organic prod. is high in most lakes producing black shales
- The lifetime of many lakes is short due to high SR

Summary (lacustrine systems)

- Some distinctive features:
 - A limited number of faunal elements
 - Sparse bioturbation
 - Absence of marine fauna
 - Black shale horizon (w. little pyrite)
 - Sodium carbonate minerals
 - Repeated intervals of desiccation and soil formation (closed basins)
 - Successions with marked lithological variations and pronounced cyclicity