Evaporites

Evaporites

- Evaporites are chemical sediments precipitated from water following evaporative concentration of dissolved salts

- Principal evaporite minerals
  - Carbonates
    - Calcite ($CaCO_3$)
    - Dolomite ($CaMg(CO_3)_2$)
  - Sulfates
    - Gypsum ($CaSO_4 \cdot 2H_2O$)
    - Anhydite ($CaSO_4$)
  - Chlorides
    - Halite (NaCl)
    - Sylvite (KCl)

Controls on Formation of Evaporite Deposits

- Normal Evaporative Sequence
  - $CaCO_3$, 1.8X [SW]
  - $CaSO_4$, 3.8X
  - NaCl, 10.6X
  - K salts, >70X

- ~65X height of water column to height of resulting sediment column
- Coastal basins normally have too high humidity to get K salts, these form mostly in arid settings

Controls

- Brine Composition
  - Continental waters vs seawater
  - Cont. waters have far more diverse mineralogy derived from weathering of source terrain
- Basin Hydrology
  - Dynamic balance, need continual recharge
  - Need a basal aquitard as well as narrow sill in order to get high degree of brine supersaturation
  - Inflow – outflow (through sill or leaky basin) needs to be balanced

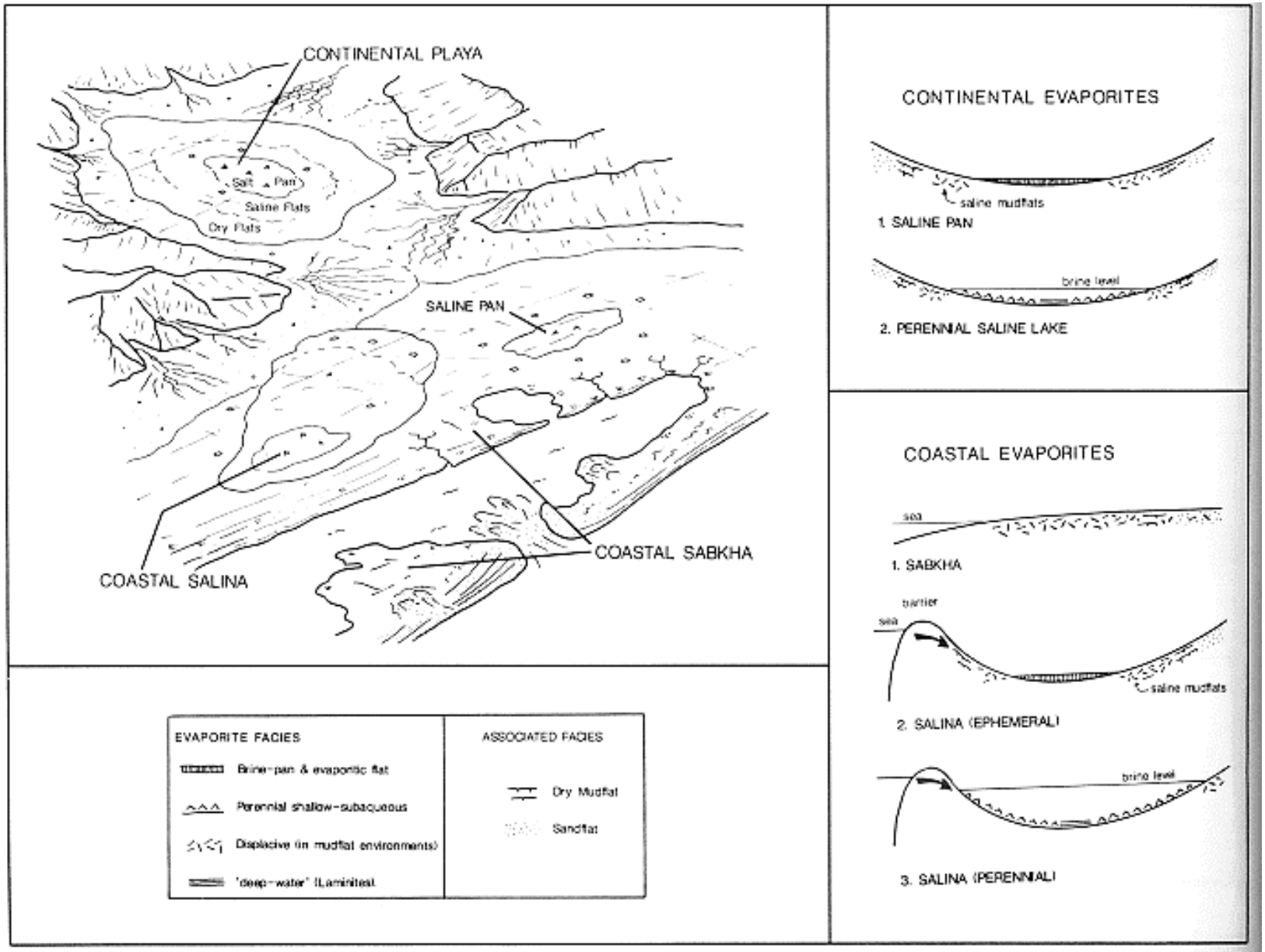
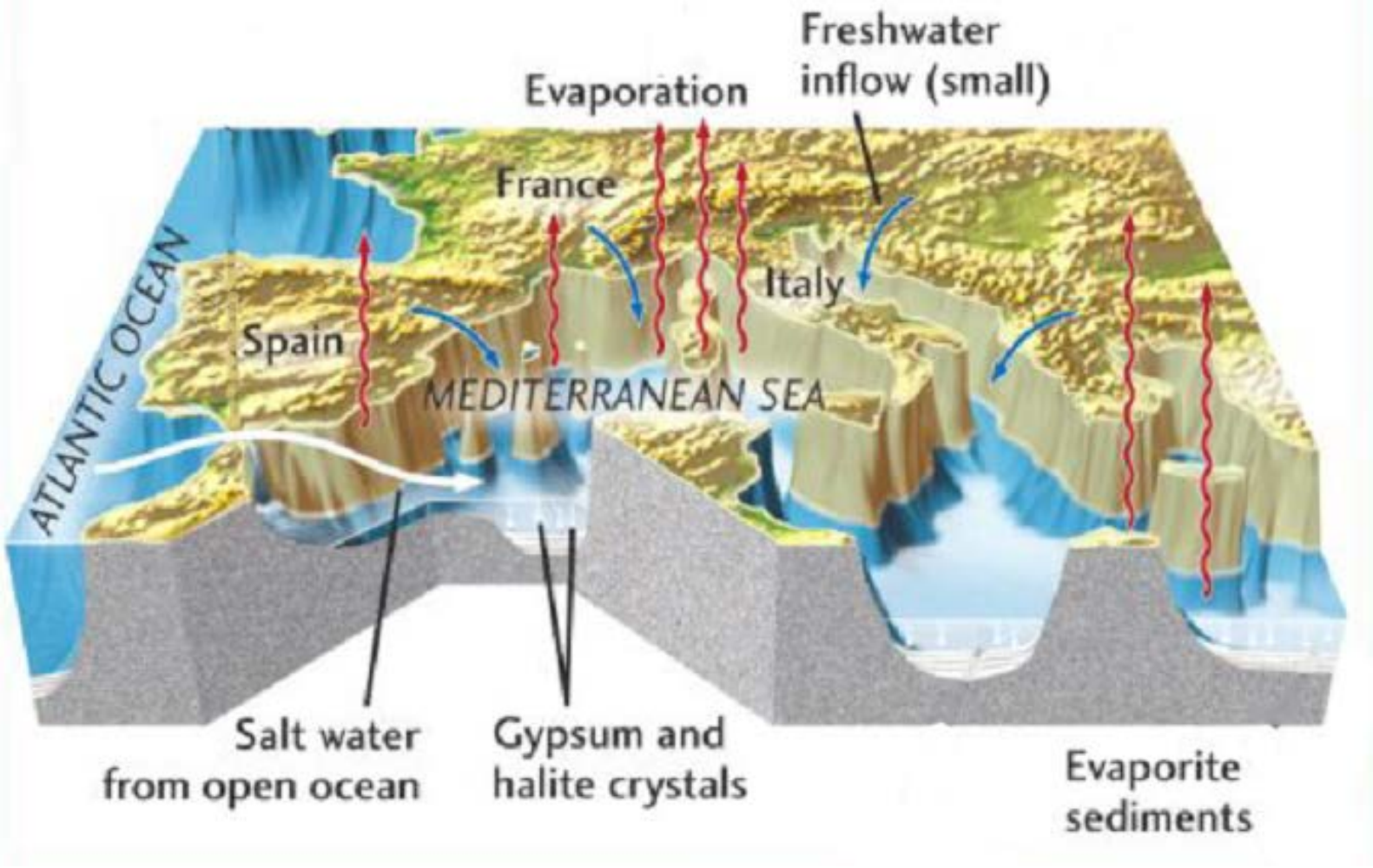


Figure 3 Modern evaporite depositional environments; diagram courtesy of C.R. Handford. Evaporites form in non-marine interior basins with playa lakes, salt pans and mud flats (continental sabkhas), coastal supratidal mud flats (marine sabkhas) and marine-fed, coastal lagoons and salt pans (salinas).

Messian Salinity Crisis (7-5 Ma, late Miocene)

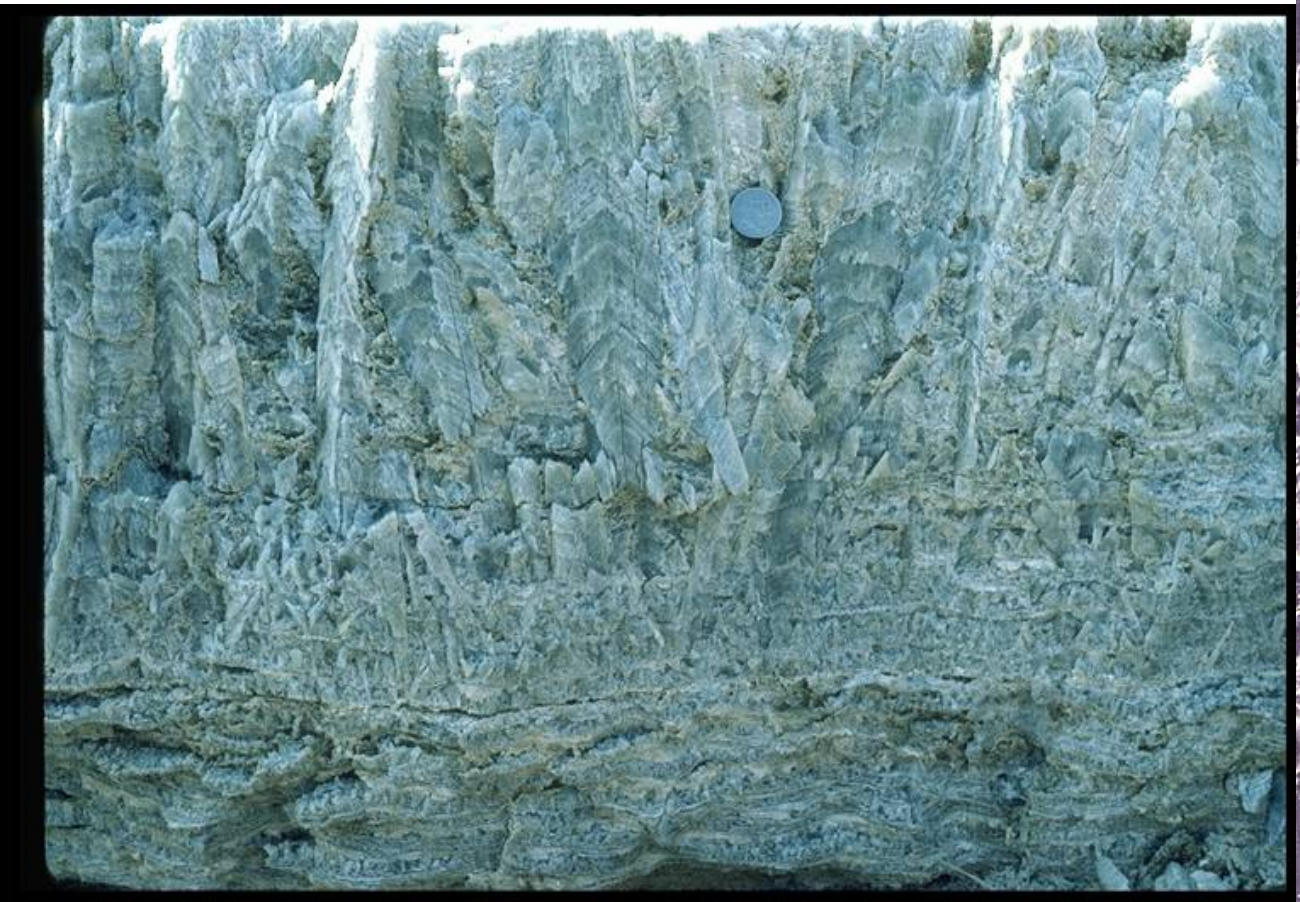
- Mediterranean Sea became isolated
  - Eustatic sealevel fall, tectonic uplift
- Widespread deposition of evaporites

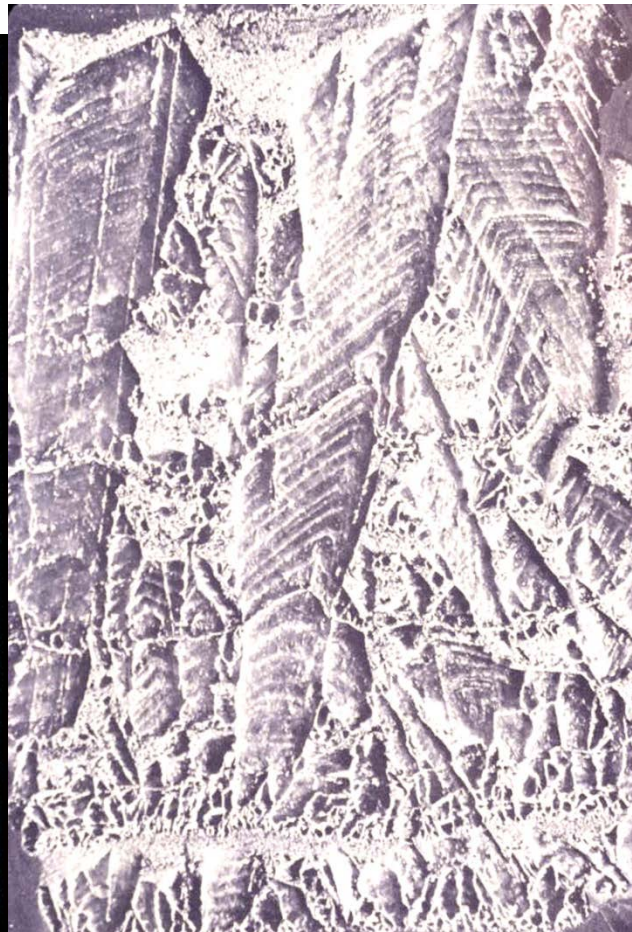


Kinds of Evaporites: Sulfates

- Gypsum-anhydrite cycle
  - Deposition normally as gypsum ($CaSO_4.2H_2O$)
  - Burial dehydration changes gypsum to anhydrite ($CaSO_4$)
  - Uplift rehydrates anhydrite to gypsum
- Dominant textures
  - Laminated
    - Thin, alternating layers of evaporite and matrix (tc/carbonate/organic matter)
  - Nodular
    - Irregularly shaped lumps separated by matrix
    - Early displacive fabrics, syn-sedimentary
    - “chicken wire” and enterolithic structures as additional examples
  - Massive
    - Lacking internal structure

- Bottom-growth gypsum
  - Precipitated on floor of lakes, lagoons & shallow shelves
  - Variety of crystal forms, some quite spectacular
  - Selenitic gypsum (grows vertically, almost like grass)
    - Commonly grows vertically, almost as grass does

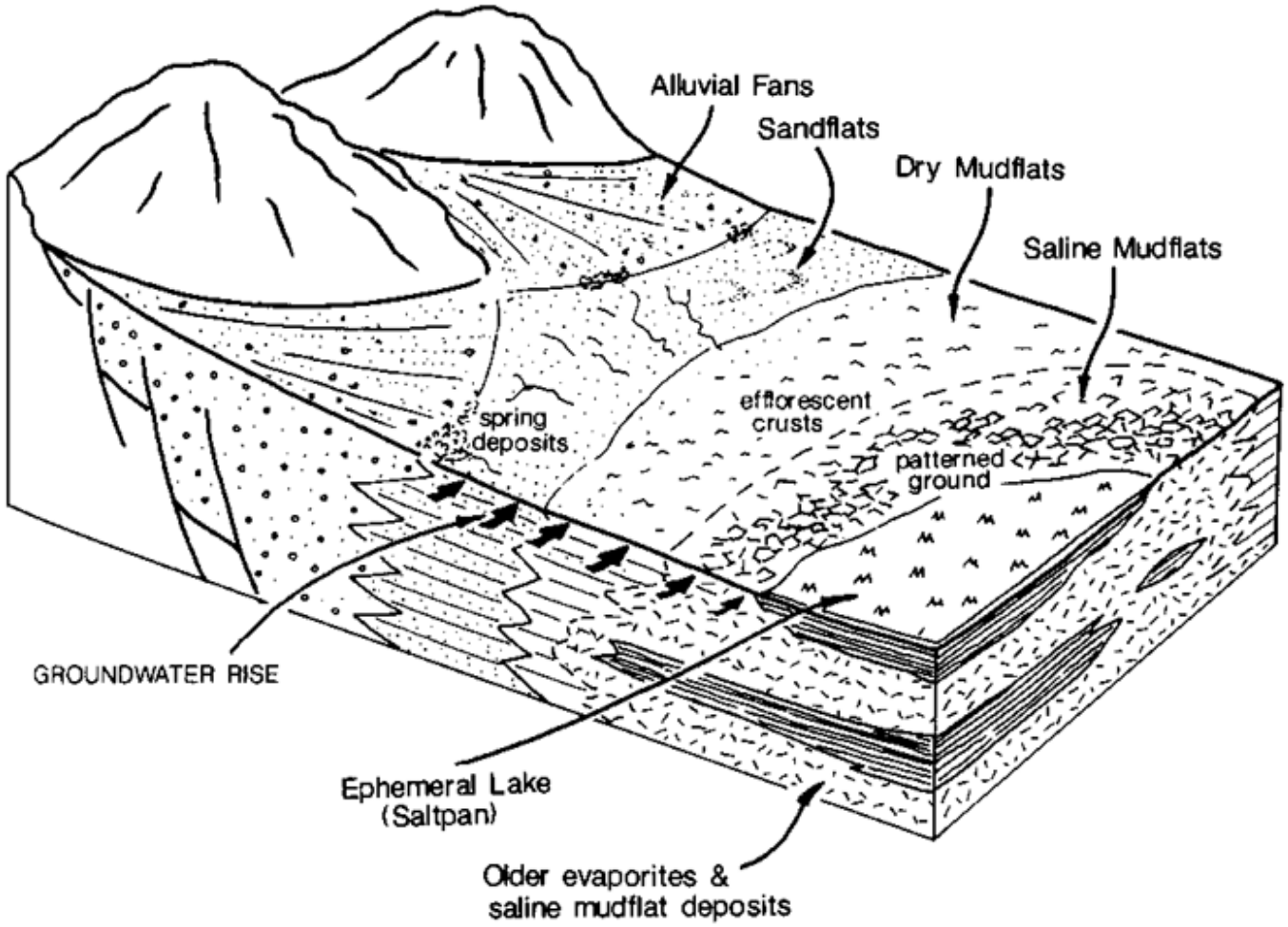




Crystalline Gypsum (Selenite) in Continental Sabkha

Nodular Gypsum in Sabkha

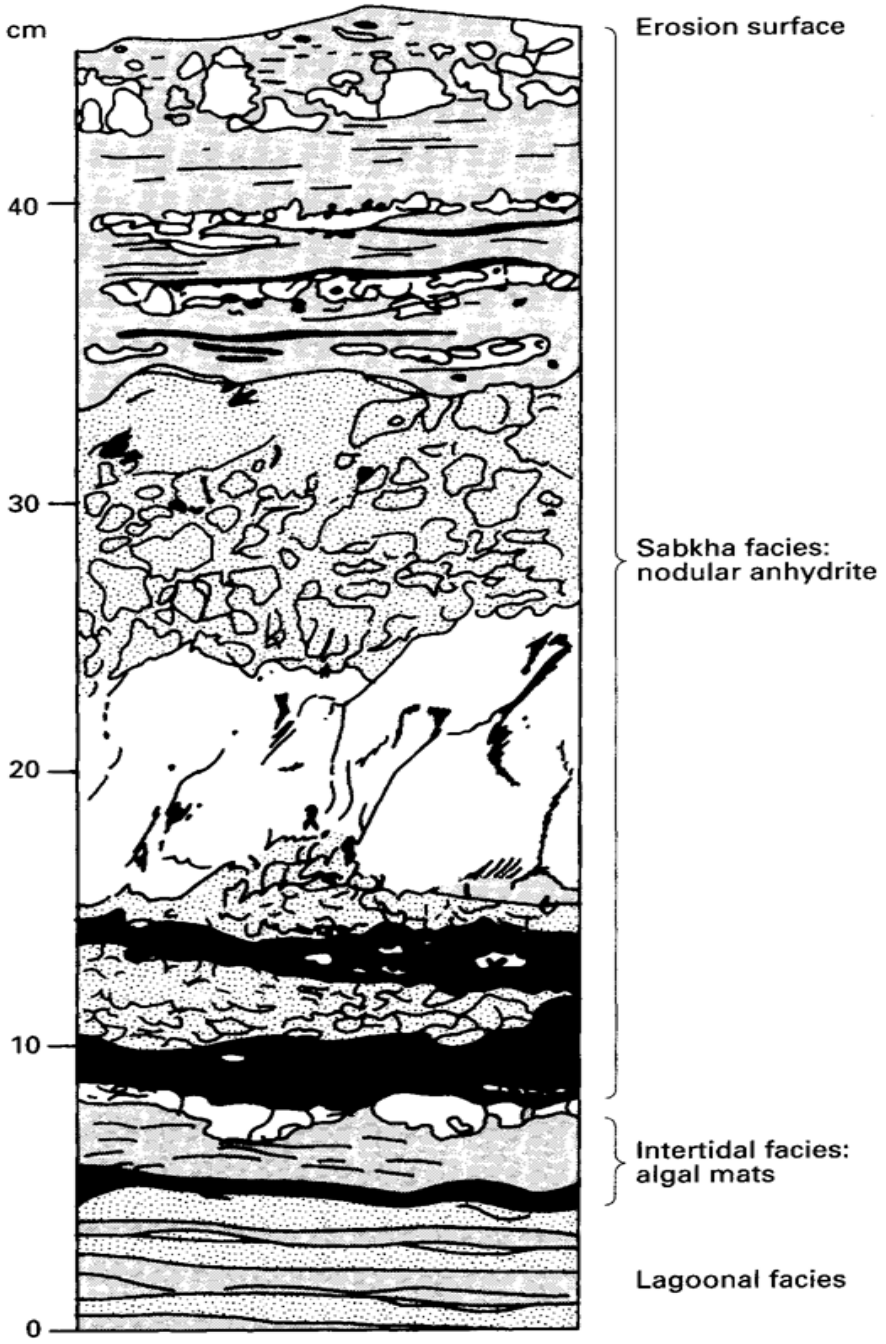
Continental Evaporite Environments: Perennial Saline Lake or Salt Pan



Sabkha

- Arabic name for salt-flat
- Flat, very saline areas lying just above the water table

Example of mudflat deposits on coastal sabkha



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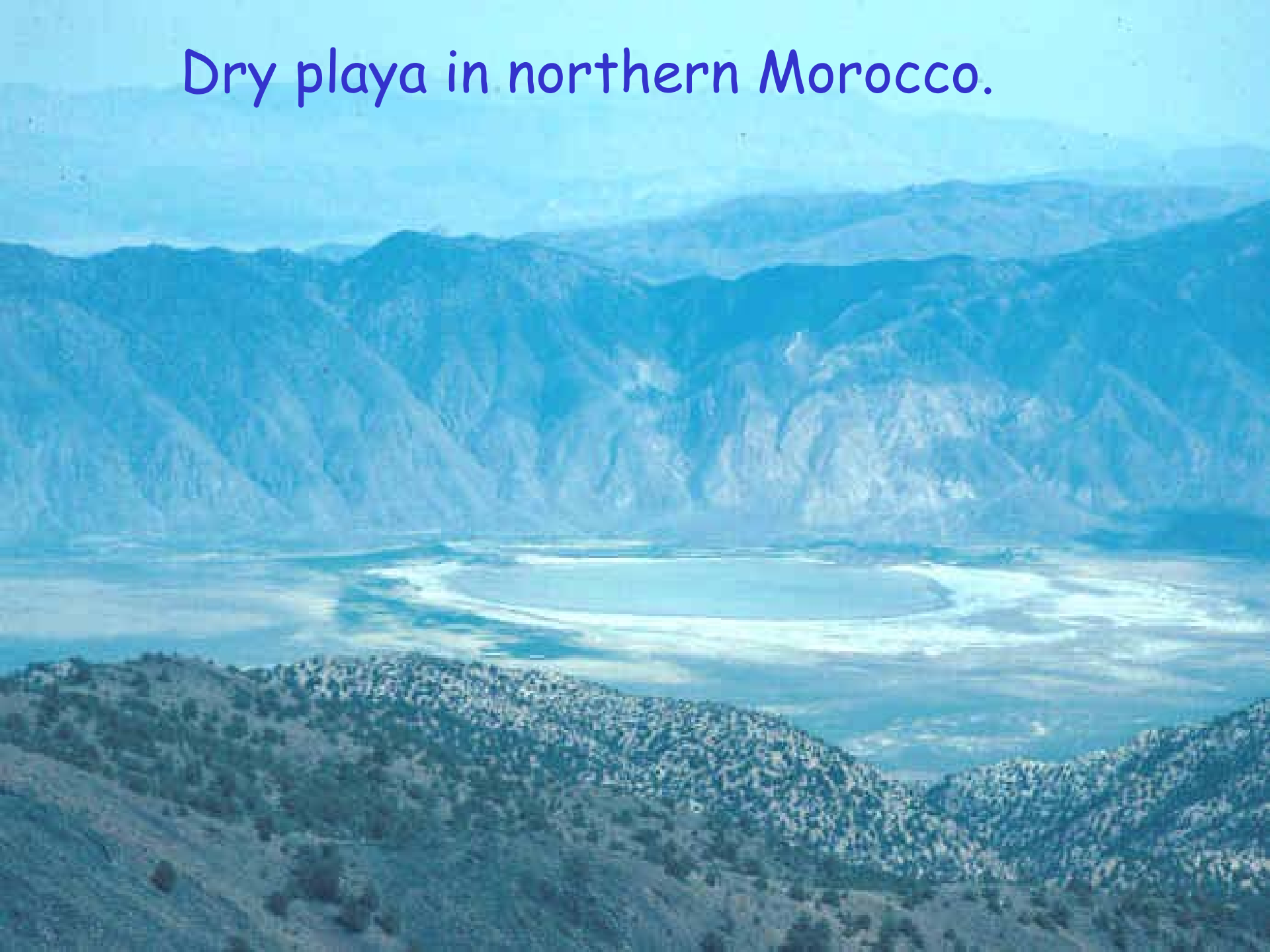
Kinds of Evaporites: Chlorides

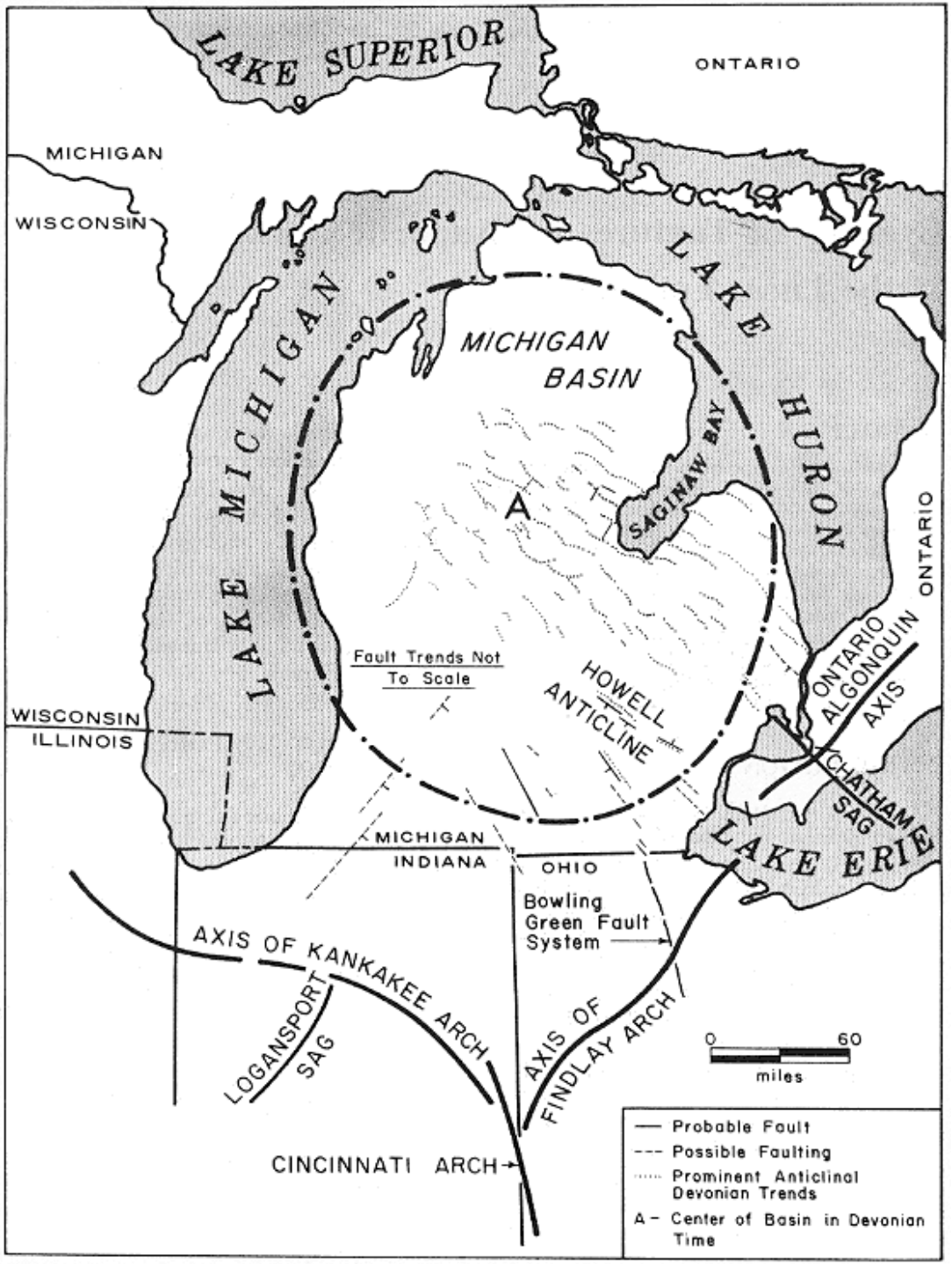
- Halite (NaCl)
  - Major component of large evaporite basin fills
  - Major mineral of modern salt lakes and saline pans
- Dominant textures
  - Laminated and well bedded
  - Crystals
    - Chevron
    - Cumuulate
    - Rich in inclusions


Dry playa in northern Morocco.

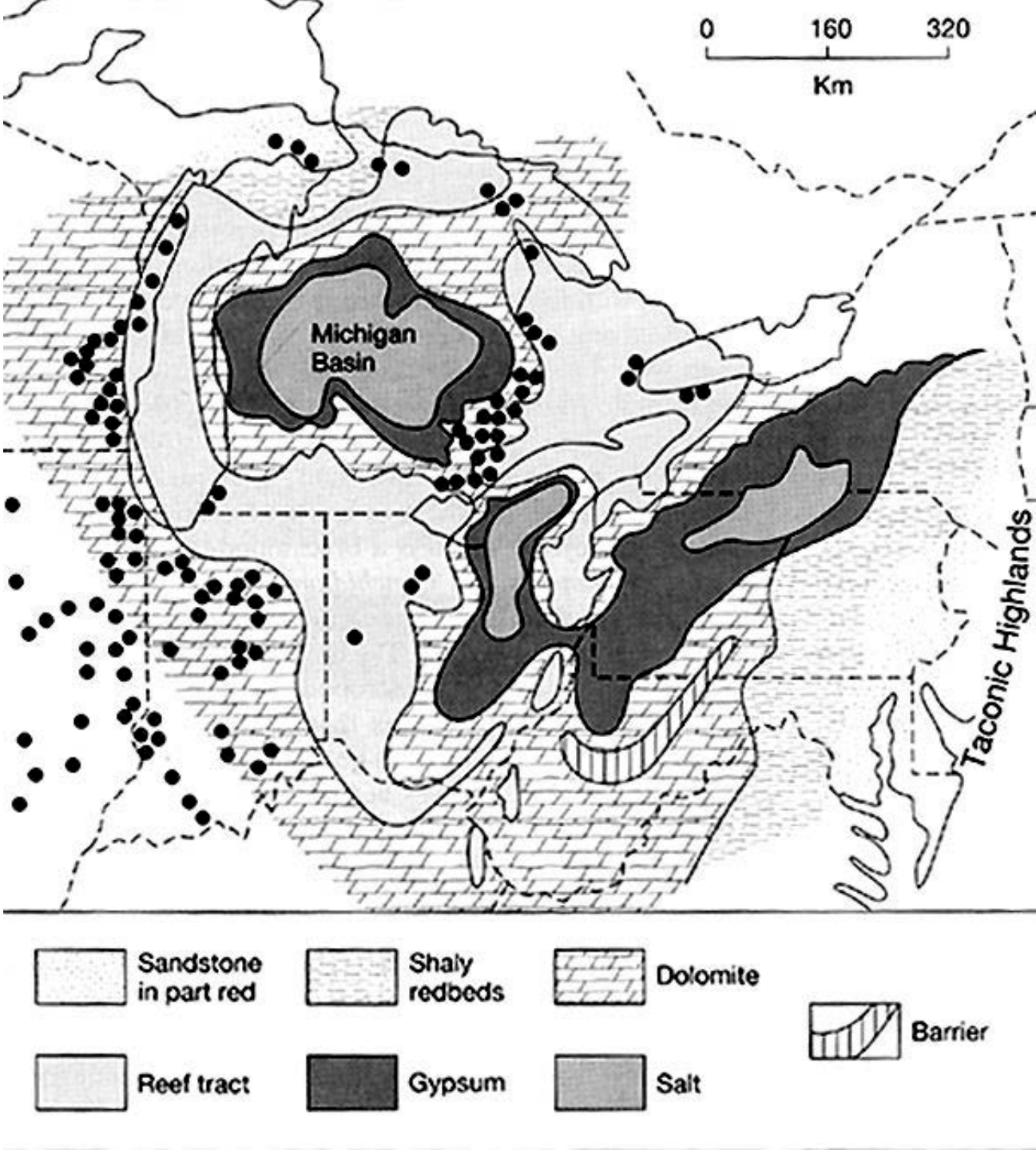

BADWATER
-282 FT. -86 METERS


BADWATER BASIN
282 FEET/85.5 METERS
BELOW SEA LEVEL

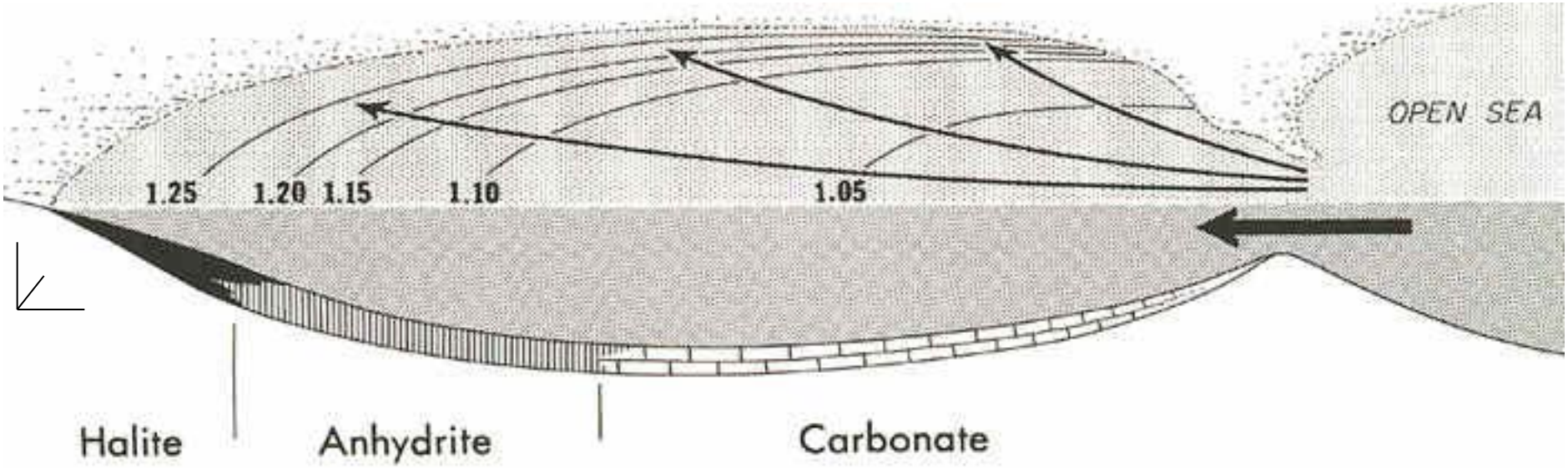

Lily-pad halite raft, shallow lagoon, Baja, California.


LAKE SUPERIOR
ONTARIO
MICHIGAN
WISCONSIN
LAKE MICHIGAN
MICHIGAN BASIN
LAKE HURON
SAGINAW BAY
A
ONTARIO
Fault Trends Not To Scale
HOWELL ANTICLINE
ONTARIO ALGONQUIN AXIS
WISCONSIN
ILLINOIS
CHATHAM SAG
LAKE ERIE
MICHIGAN
INDIANA
OHIO
Bowling Green Fault System
AXIS OF KANKAKEE ARCH
LOGANSPORT SAG
AXIS OF FINDLAY ARCH
0
60
miles
CINCINNATI ARCH
Probable Fault
Possible Faulting
Prominent Anticlinal Devonian Trends
A – Center of Basin in Devonian Time

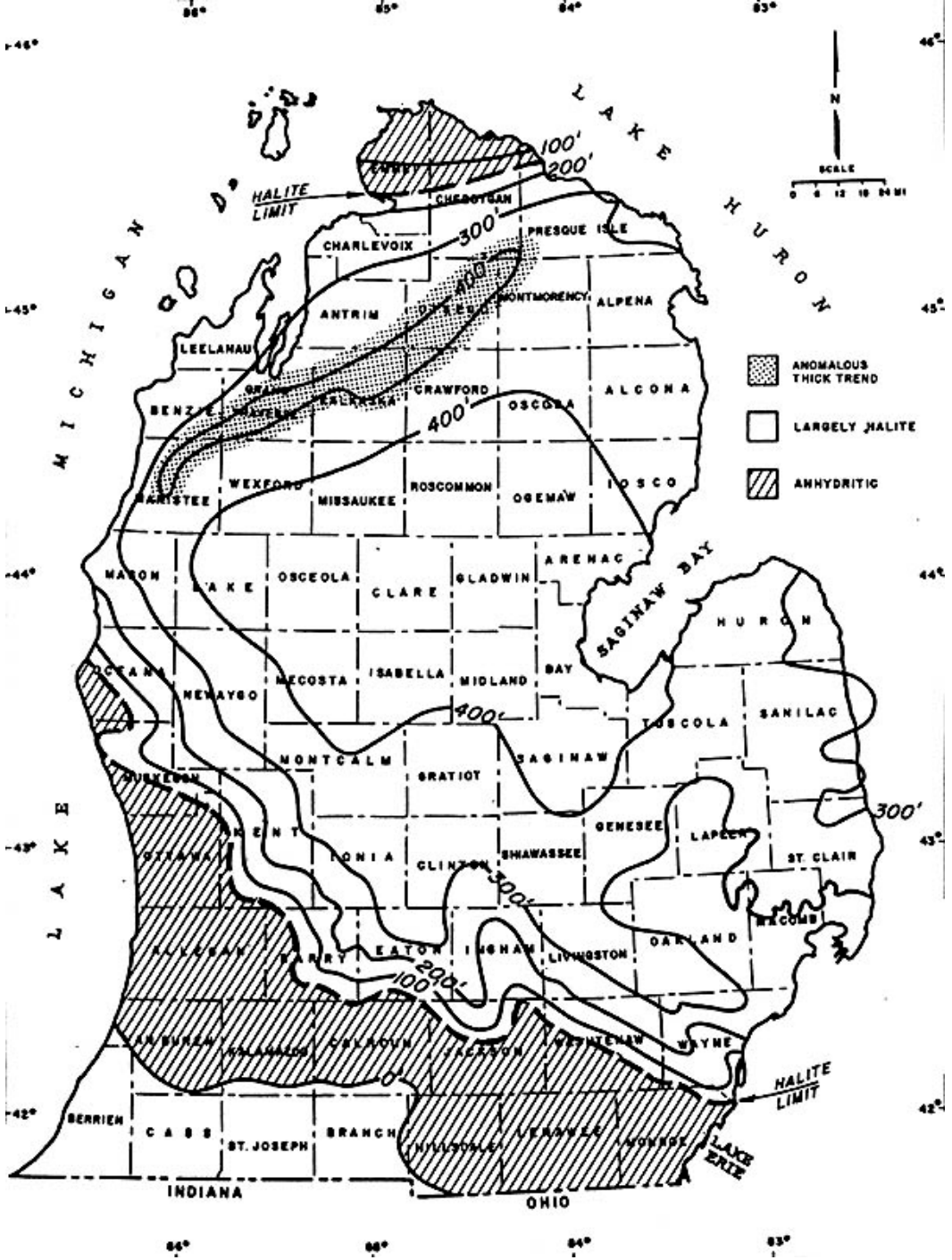
North American Silurian reefs



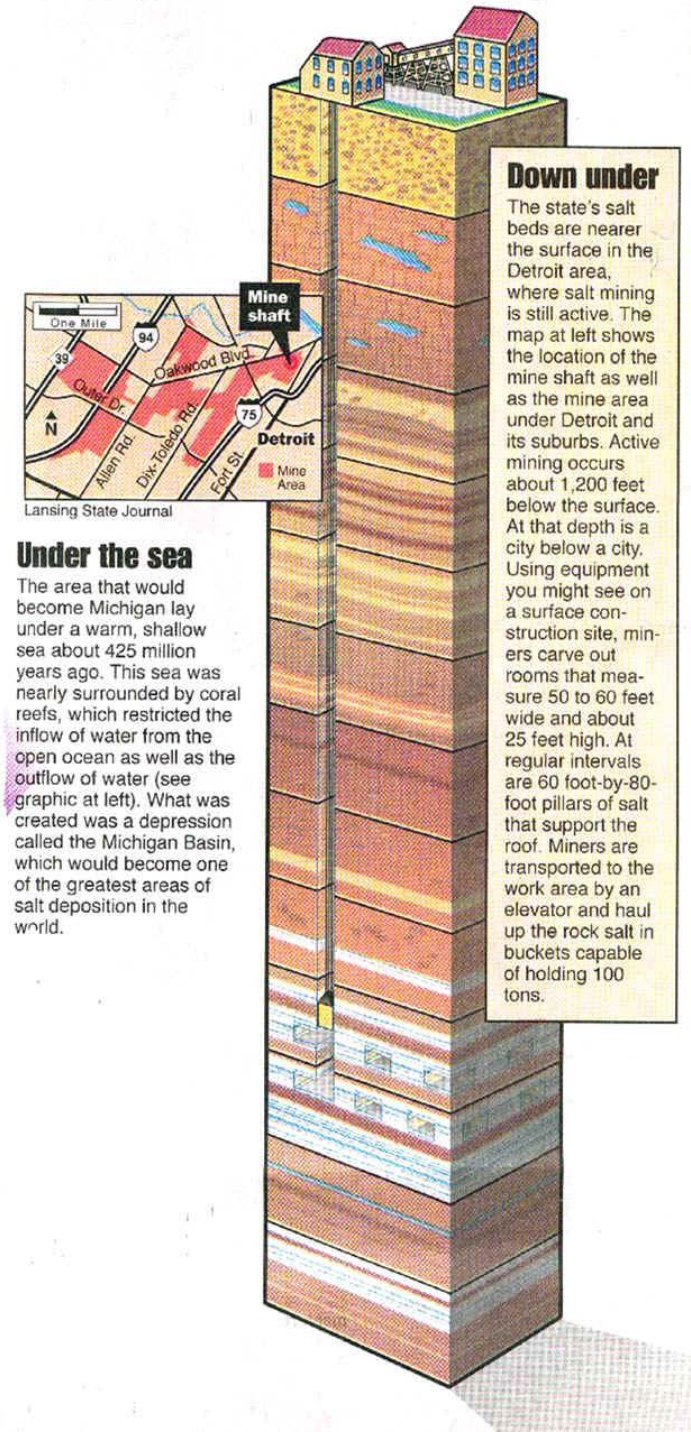
While reefs were forming, limestone and dolomite were precipitating in the deep waters of the basin near the "inlets" to the basin. In the farthest and cleanest parts of the basin, halite salts and gypsum salts (anhydrite) were precipitating.



THICKNESS OF THE SALINA SALT IN THE MICHIGAN BASIN



In 1906 the Detroit Salt and Manufacturing Company started sinking a shaft for underground mining of rock salt. As recently as a few years ago, miners at this mine, worked 1,200 feet beneath Detroit. Today it is closed.




Salt beds exposed in a Michigan salt mine. From the top to the base of the image is about a meter.