

Evaporites



Evaporites

- Evaporites are chemical sediments precipitated from water following evaporative concentration of dissolved salts
- Principal evaporite minerals
 - Carbonates
 - Calcite (CaCO_3)
 - Dolomite ($\text{CaMg}(\text{CO}_3)_2$)
 - Sulfates
 - Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
 - Anhydrite (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

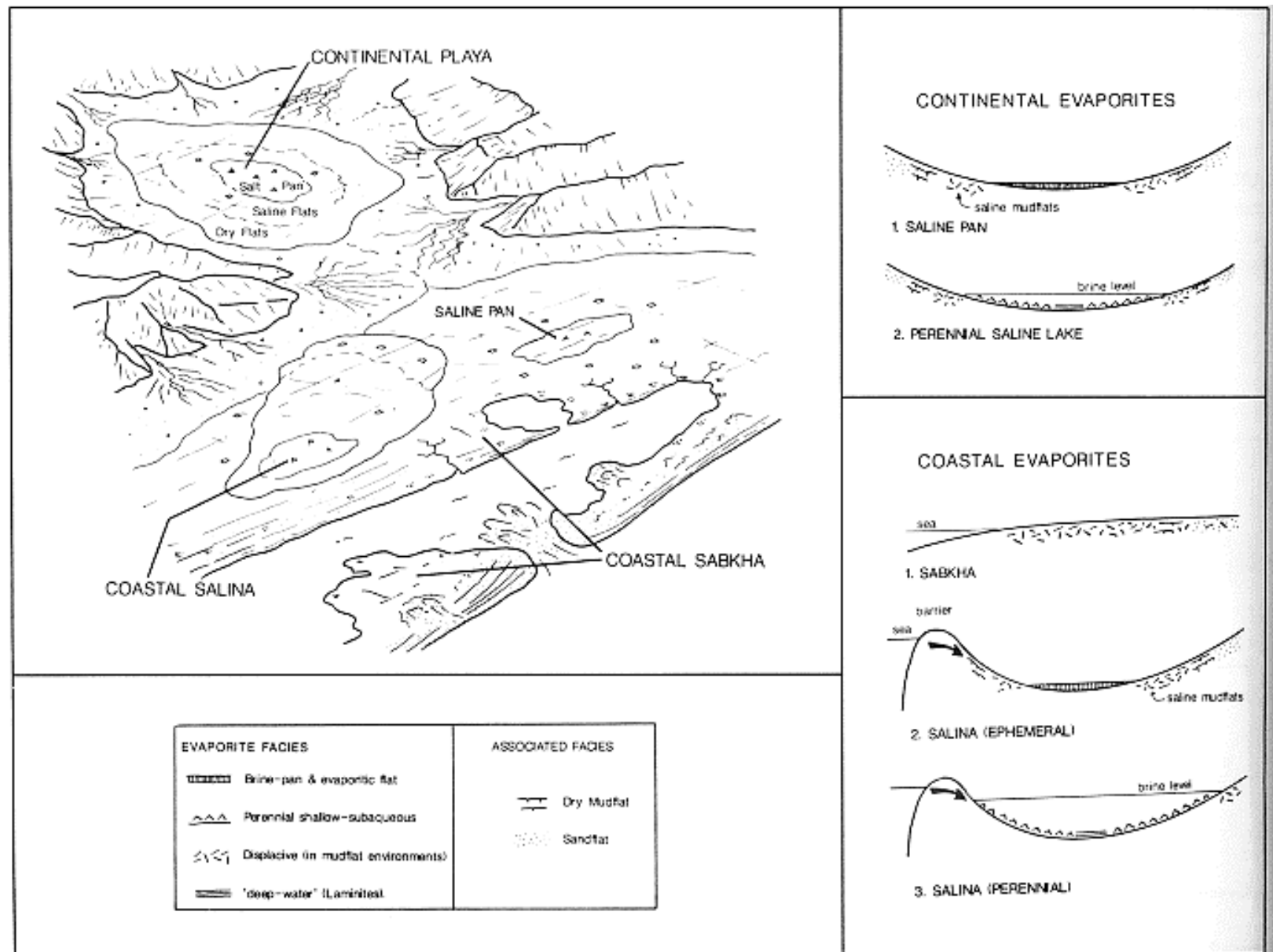
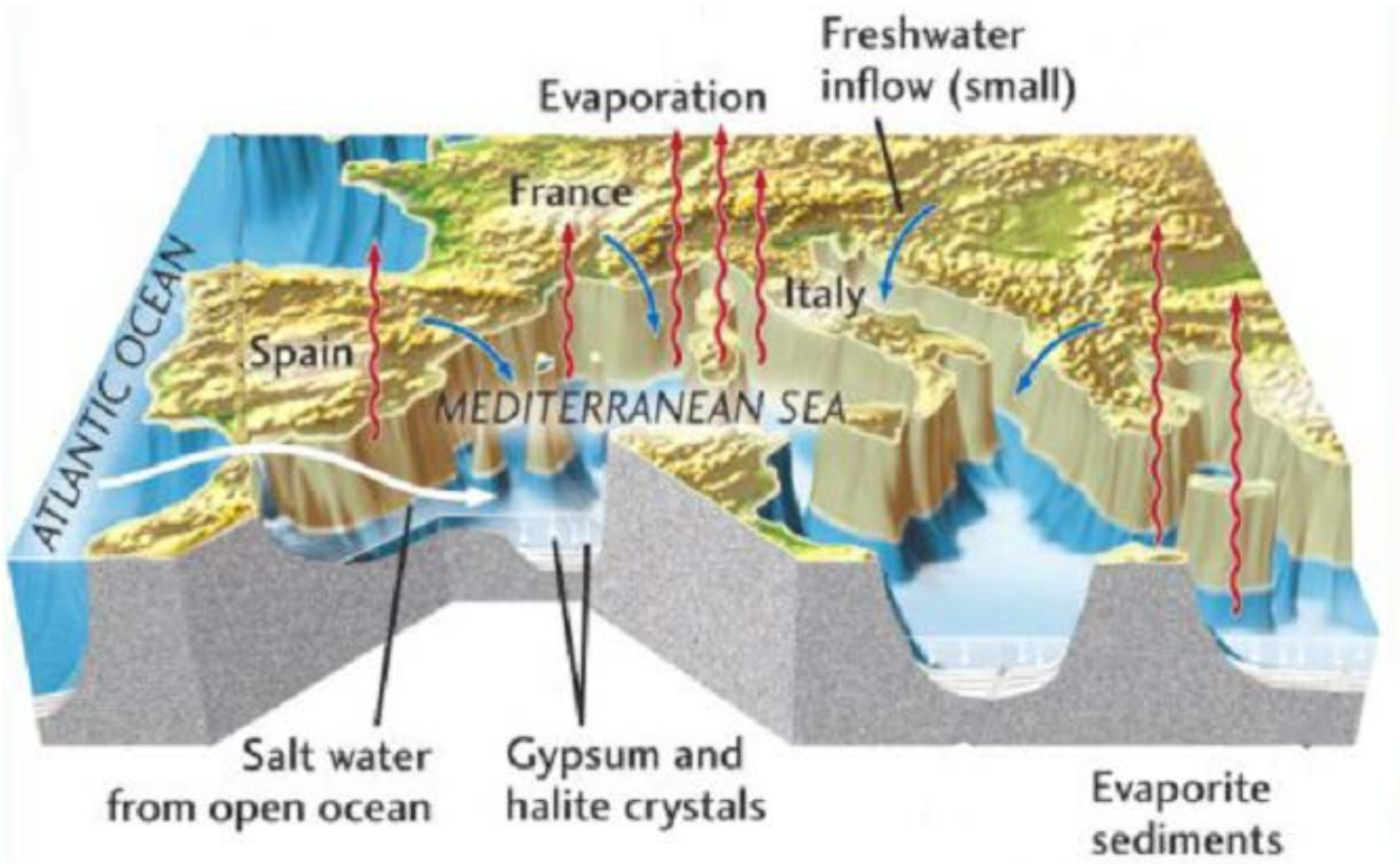


Figure 3 Modern evaporite depositional environments; diagram courtesy of C.R. Handford. Evaporites form in non-marine interior basins with playa lakes, salt pans and mud flats (continental sabkhas), coastal supratidal mud flats (marine sabkhas) and marine-fed, coastal lagoons and salt pans (salinas).

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 ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
 - 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

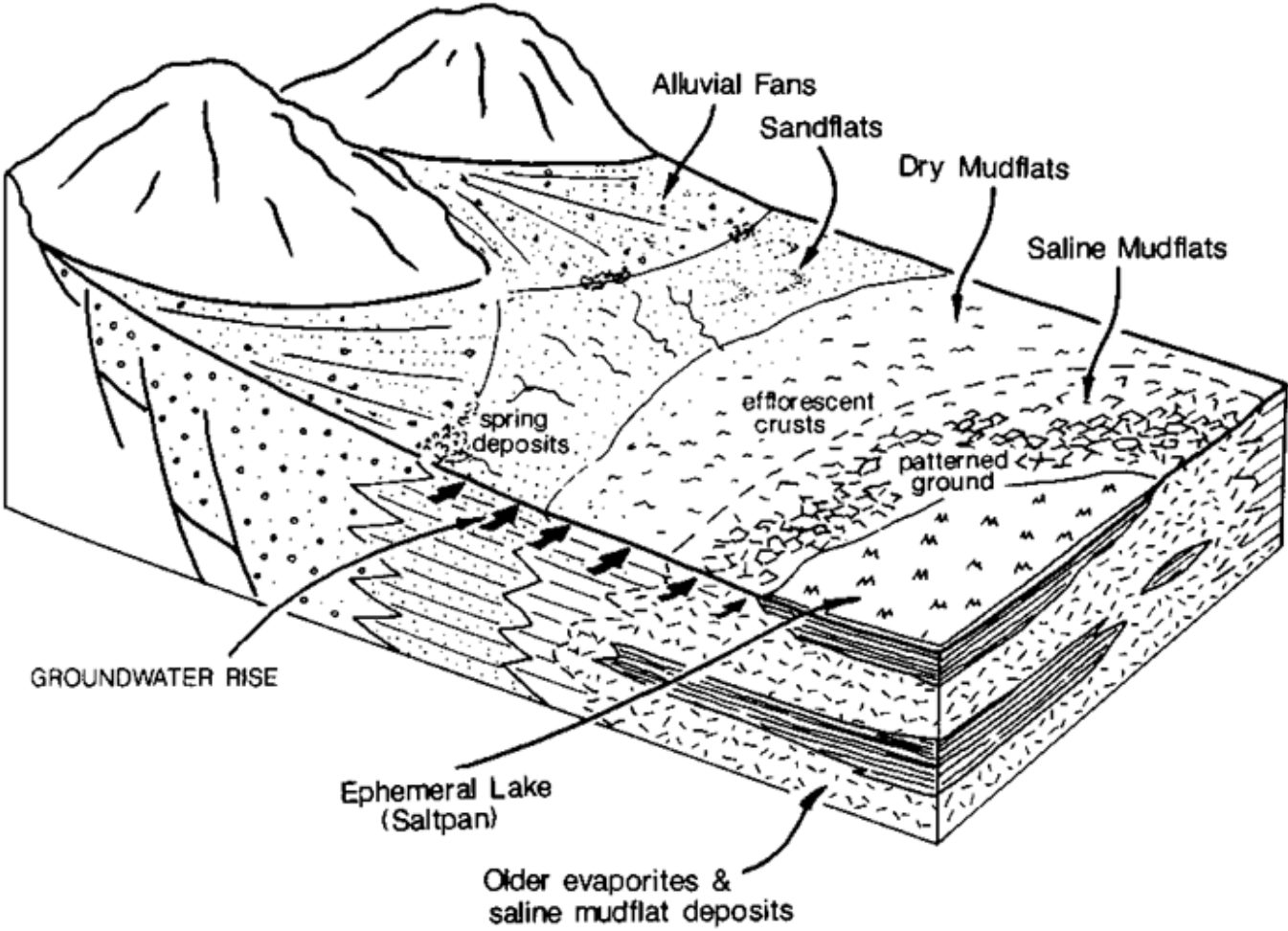


Nodular Gypsum in Sabkha





Continental Evaporite Environments: Perennial Saline Lake or Salt Pan

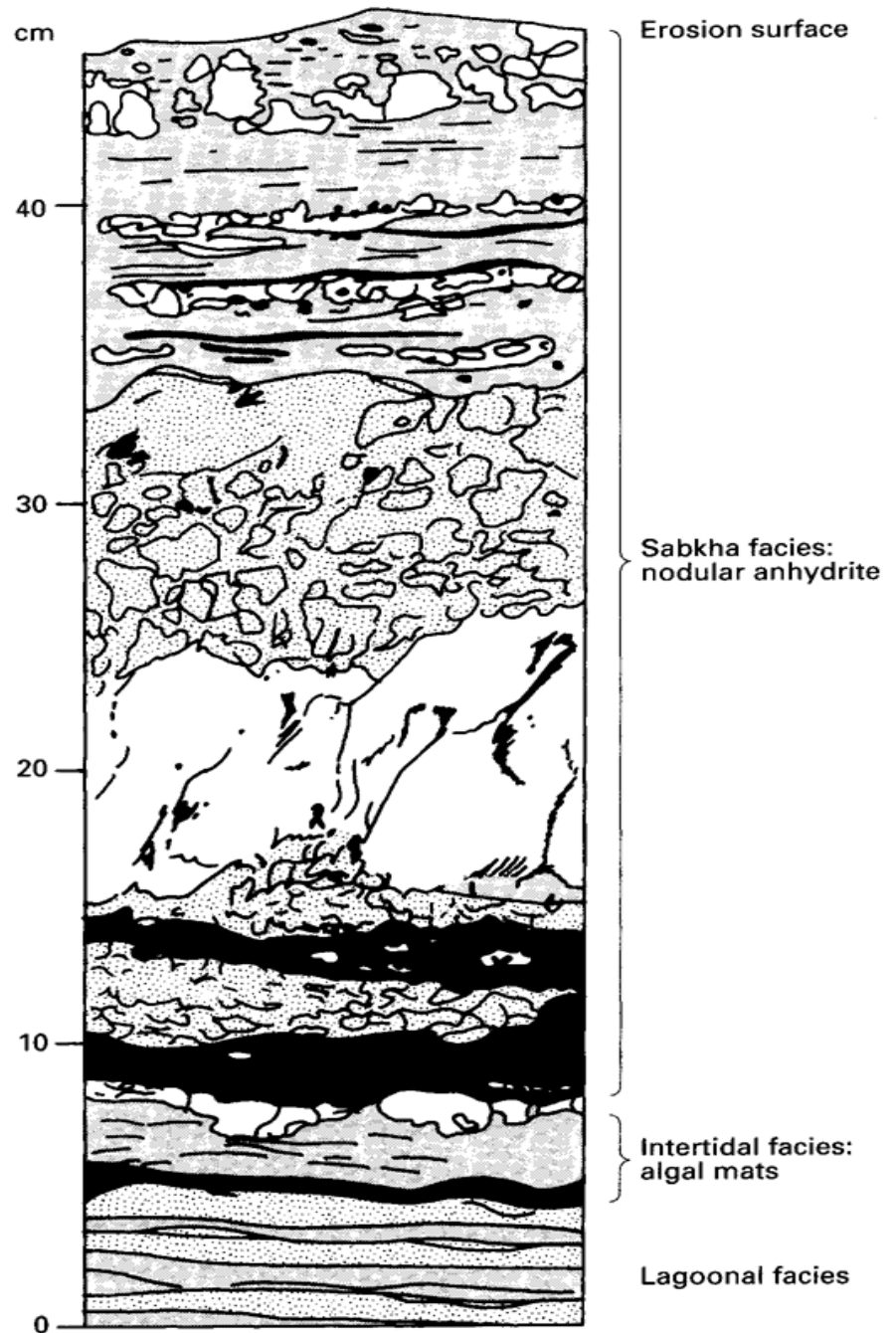


Sabkha

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



Example of mudflat deposits on coastal sabkha





0.9144 METER

GREAT NECK SAW MANUFACTURERS INC.

Great Neck

MINEOLA NEW YORK

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95

MINEOLA NEW YORK

Great Neck

GREAT NECK SAW MANUFACTURERS INC.

1 YARD = 0.9144 METERS

1 FOOT = 1.000 INCHES

1 DECMETER = 100 CM

1 METER = 1000 MM



313 314 315 316 317 318 319 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 7

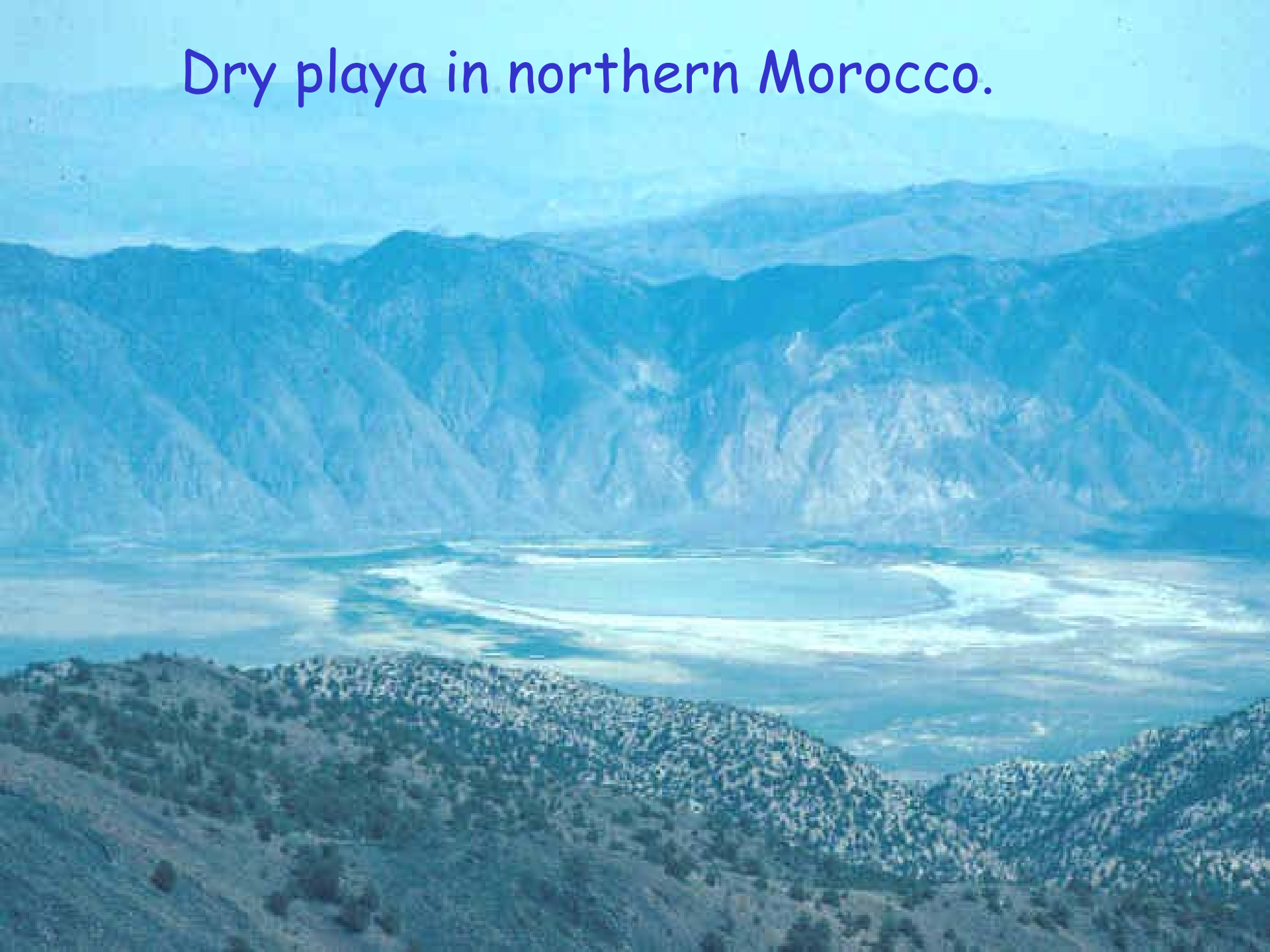




Kinds of Evaporites: Chlorides

- 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 / 855 METERS

BELOW SEA LEVEL

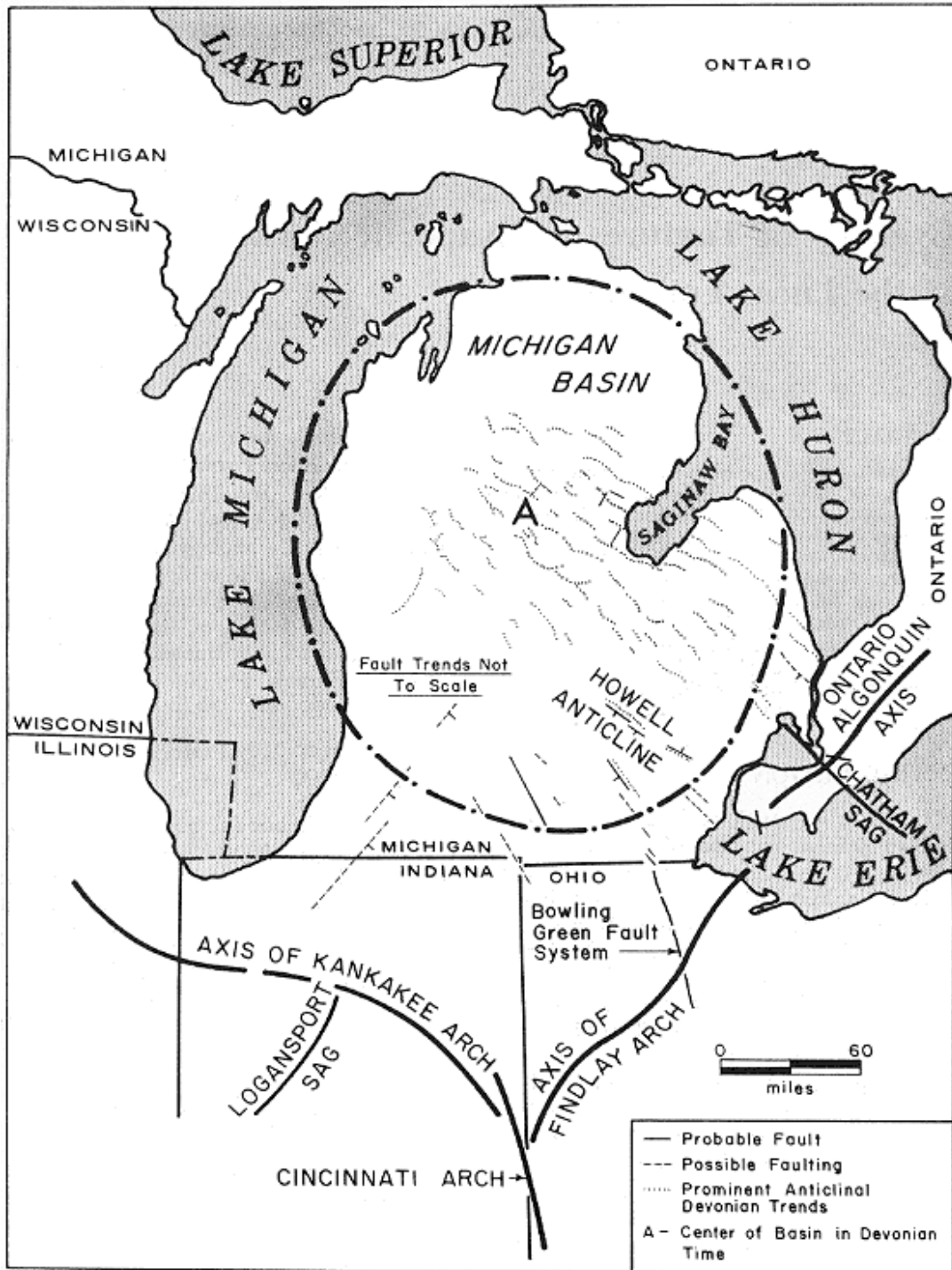




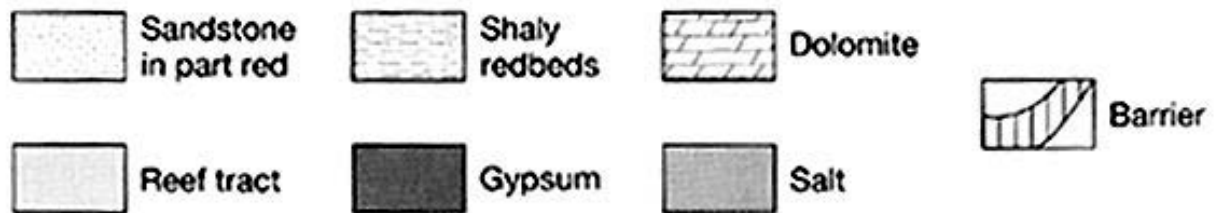
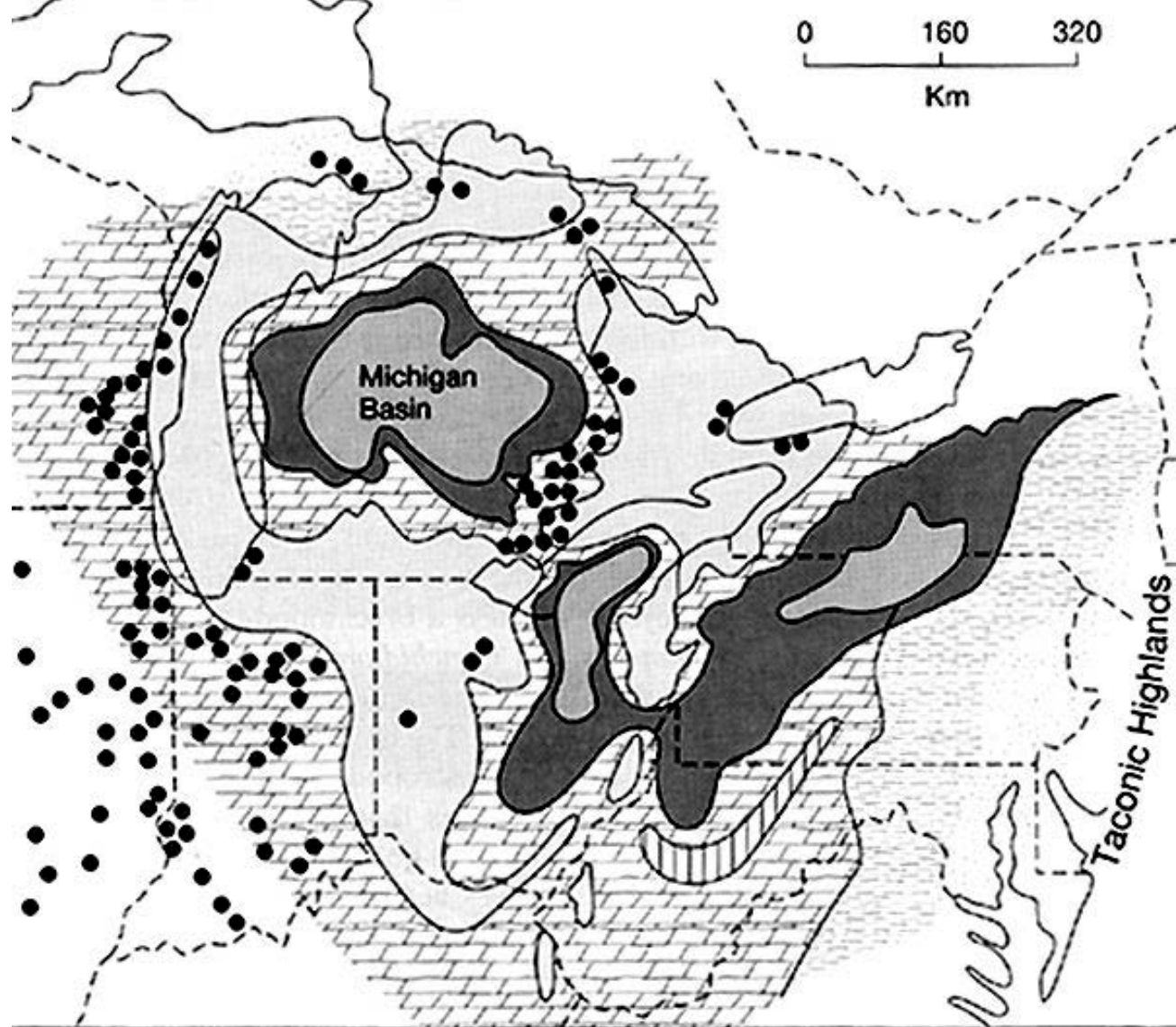


Lily-pad halite raft, shallow lagoon, Baja, California.

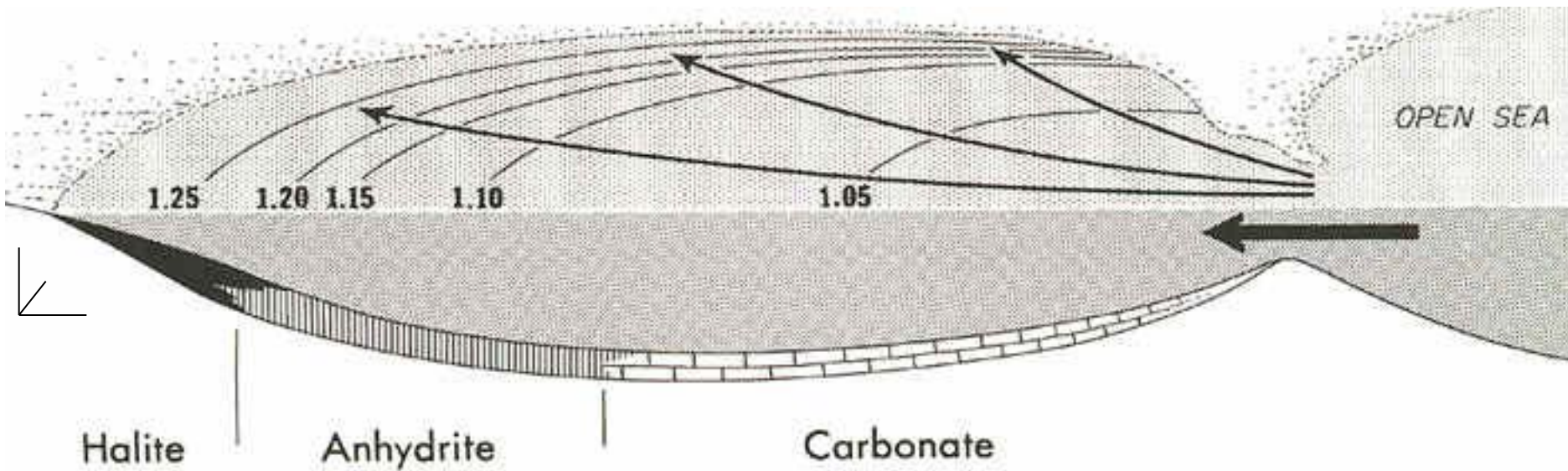




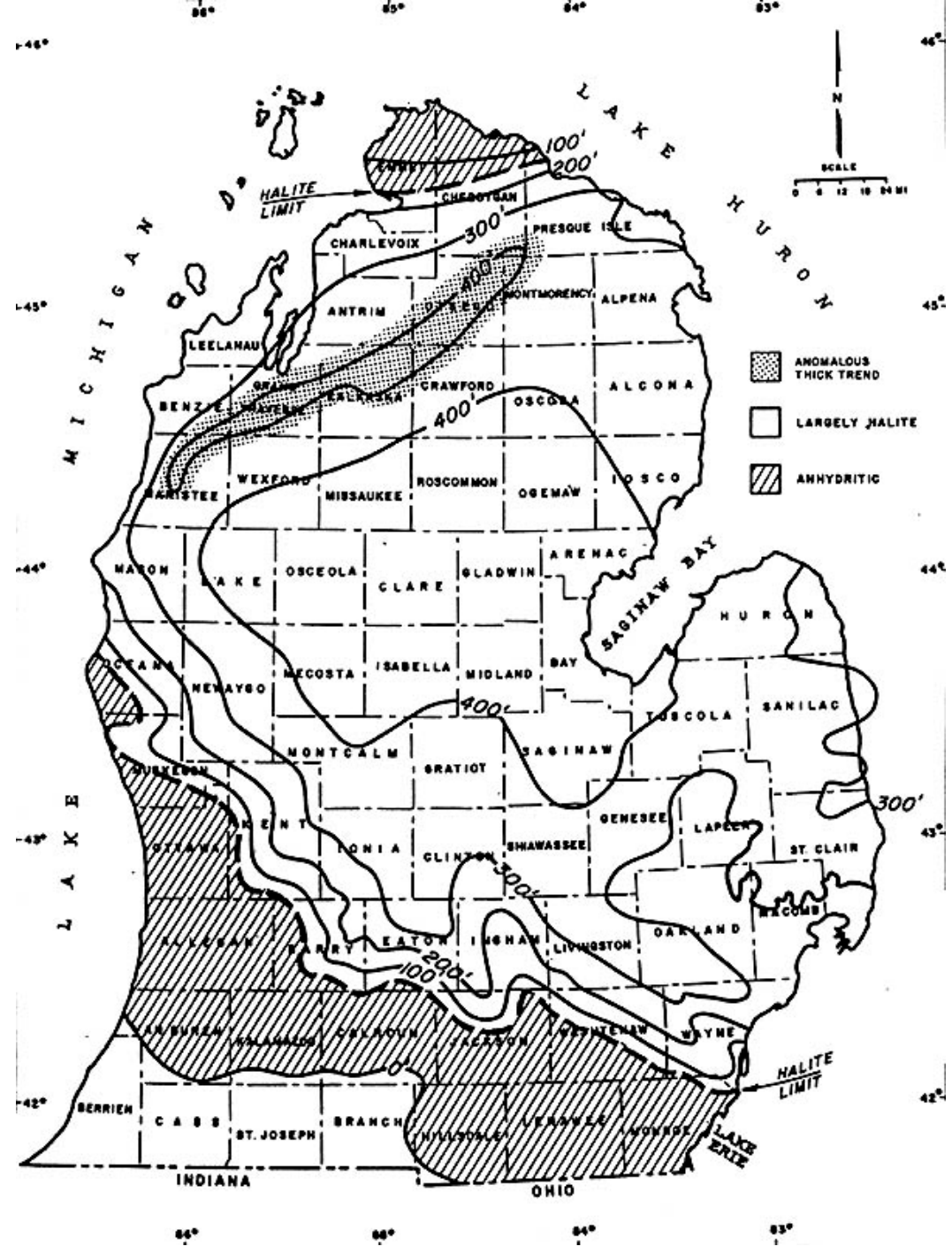
North American Silurian reefs



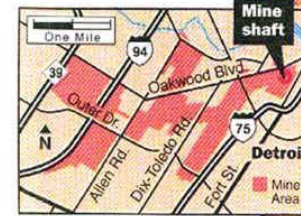
While reefs were forming, limestone and dolomite were precipitating in the deep waters of the basin near the "inlets" to the basin. In the farthest and cleanest parts of the basin, halite salts and gypsum salts (anhydrite) were precipitating.



THICKNESS OF THE SALINA SALT IN THE MICHIGAN BASIN



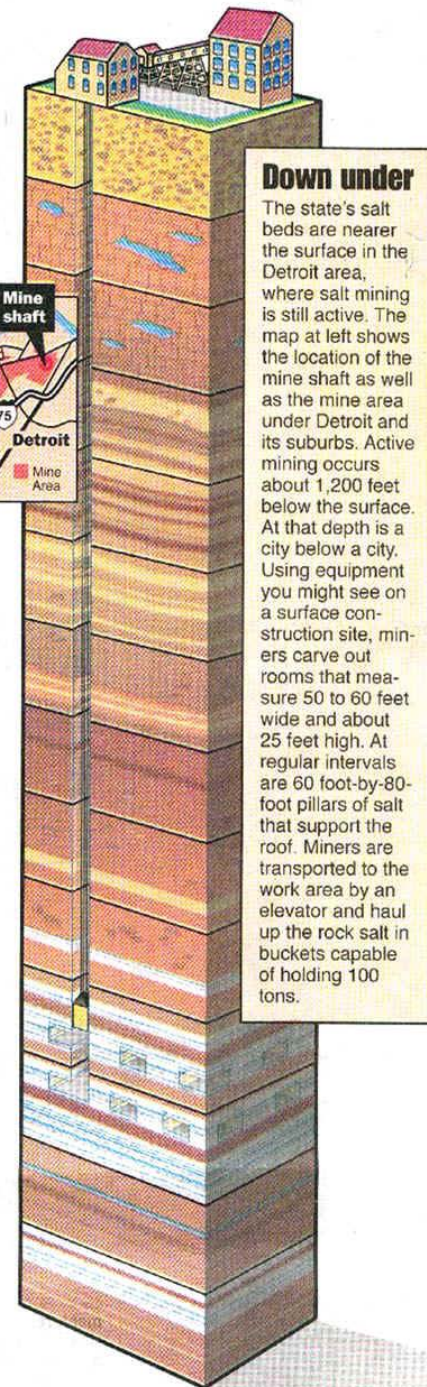
In 1906 the Detroit Salt and Manufacturing Company started sinking a shaft for underground mining of rock salt. As recently as a few years ago, miners at this mine, worked 1,200 feet beneath Detroit. Today it is closed.



Lansing State Journal

Under the sea

The area that would become Michigan lay under a warm, shallow sea about 425 million years ago. This sea was nearly surrounded by coral reefs, which restricted the inflow of water from the open ocean as well as the outflow of water (see graphic at left). What was created was a depression called the Michigan Basin, which would become one of the greatest areas of salt deposition in the world.



Down under

The state's salt beds are nearer the surface in the Detroit area, where salt mining is still active. The map at left shows the location of the mine shaft as well as the mine area under Detroit and its suburbs. Active mining occurs about 1,200 feet below the surface. At that depth is a city below a city. Using equipment you might see on a surface construction site, miners carve out rooms that measure 50 to 60 feet wide and about 25 feet high. At regular intervals are 60 foot-by-80-foot pillars of salt that support the roof. Miners are transported to the work area by an elevator and haul up the rock salt in buckets capable of holding 100 tons.

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

