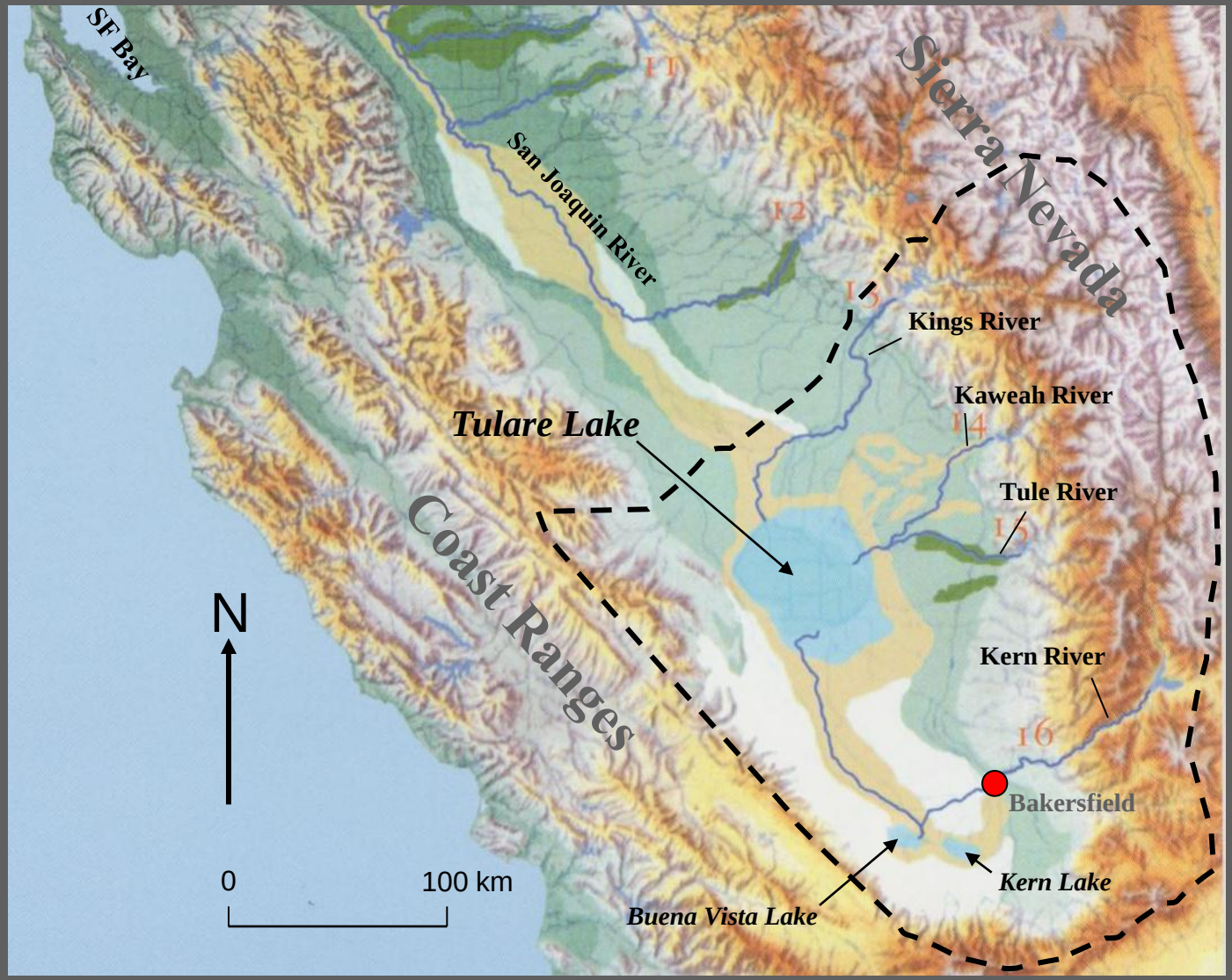
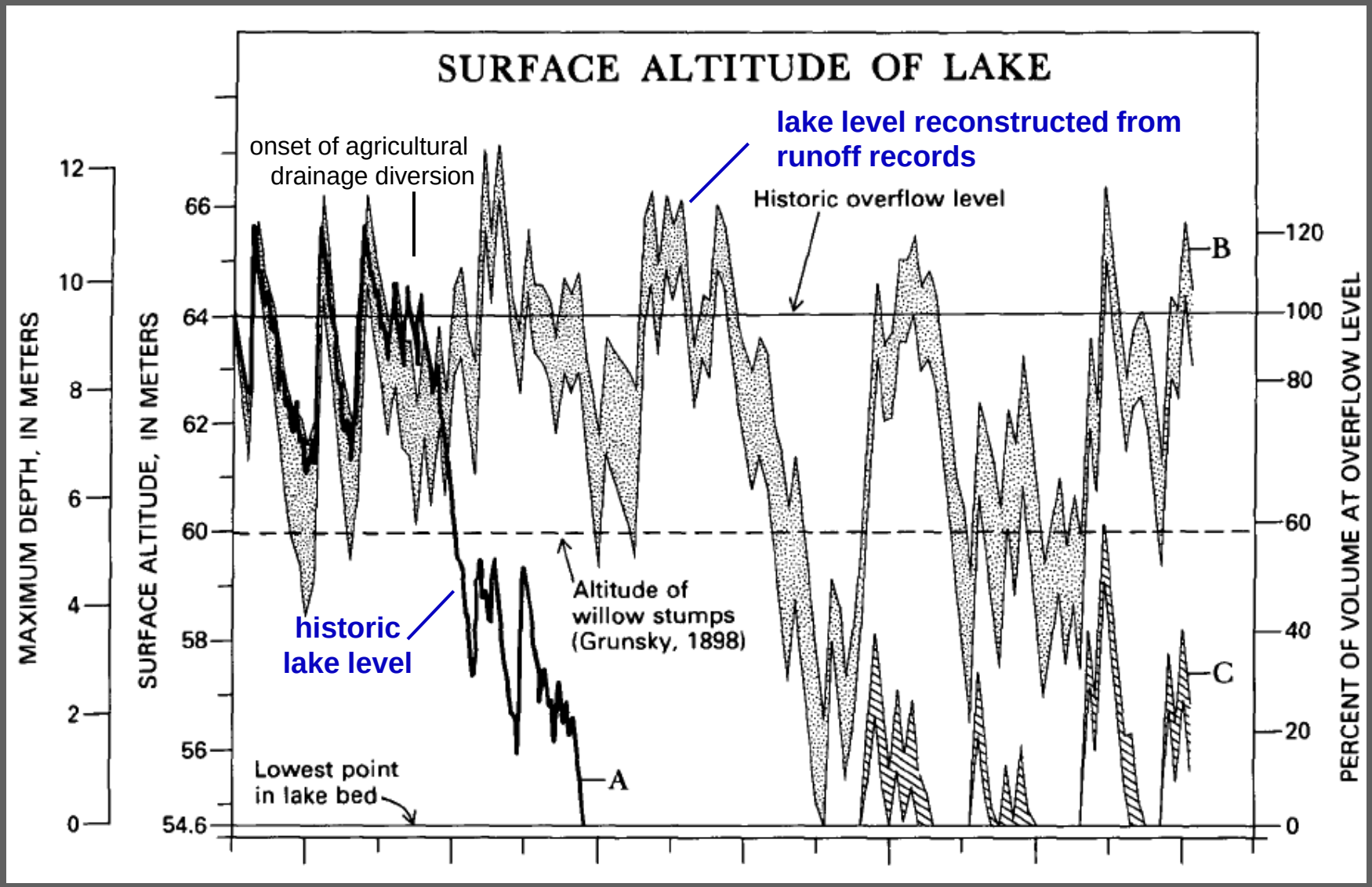
Paleorunoff Estimates from Lake-level History of Tulare Lake

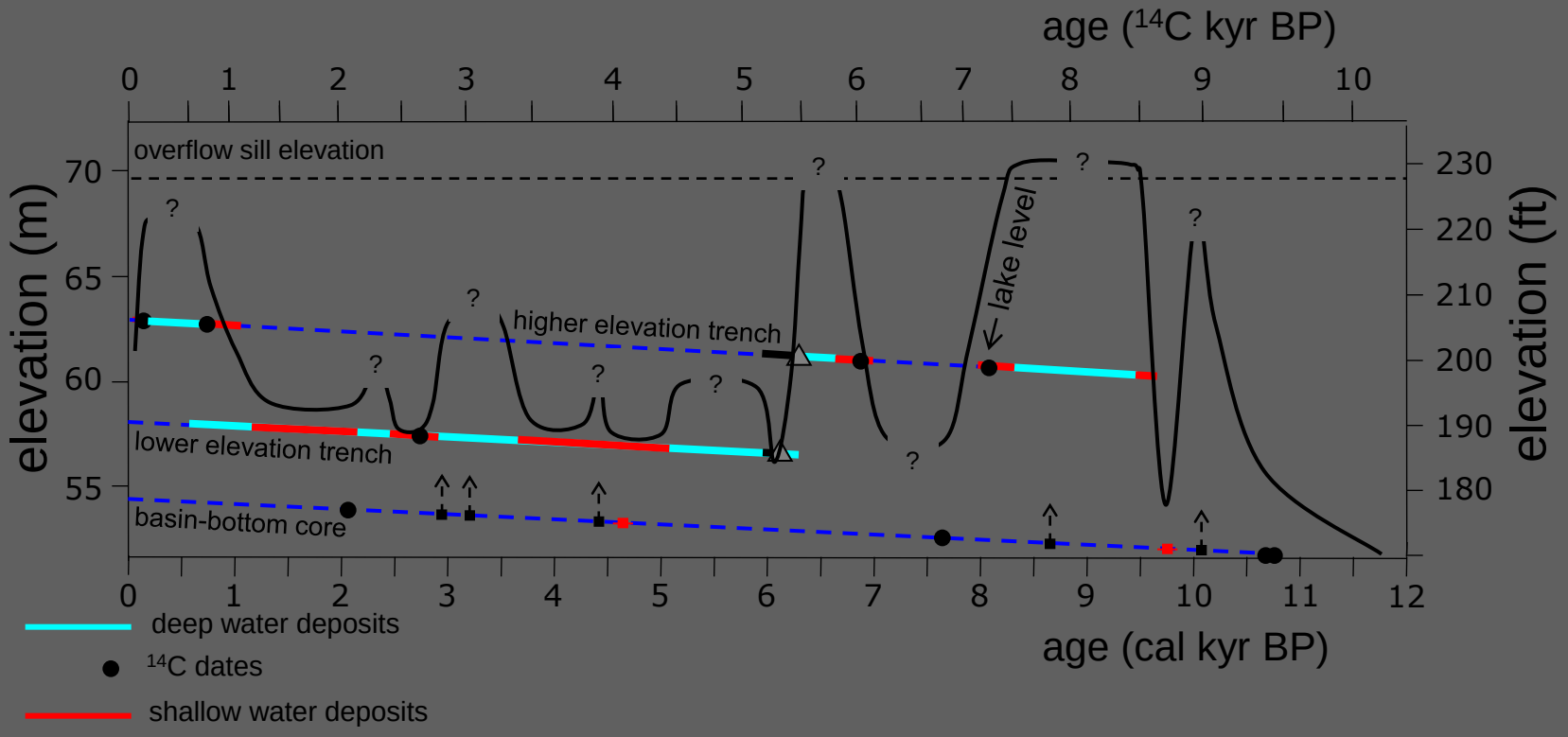


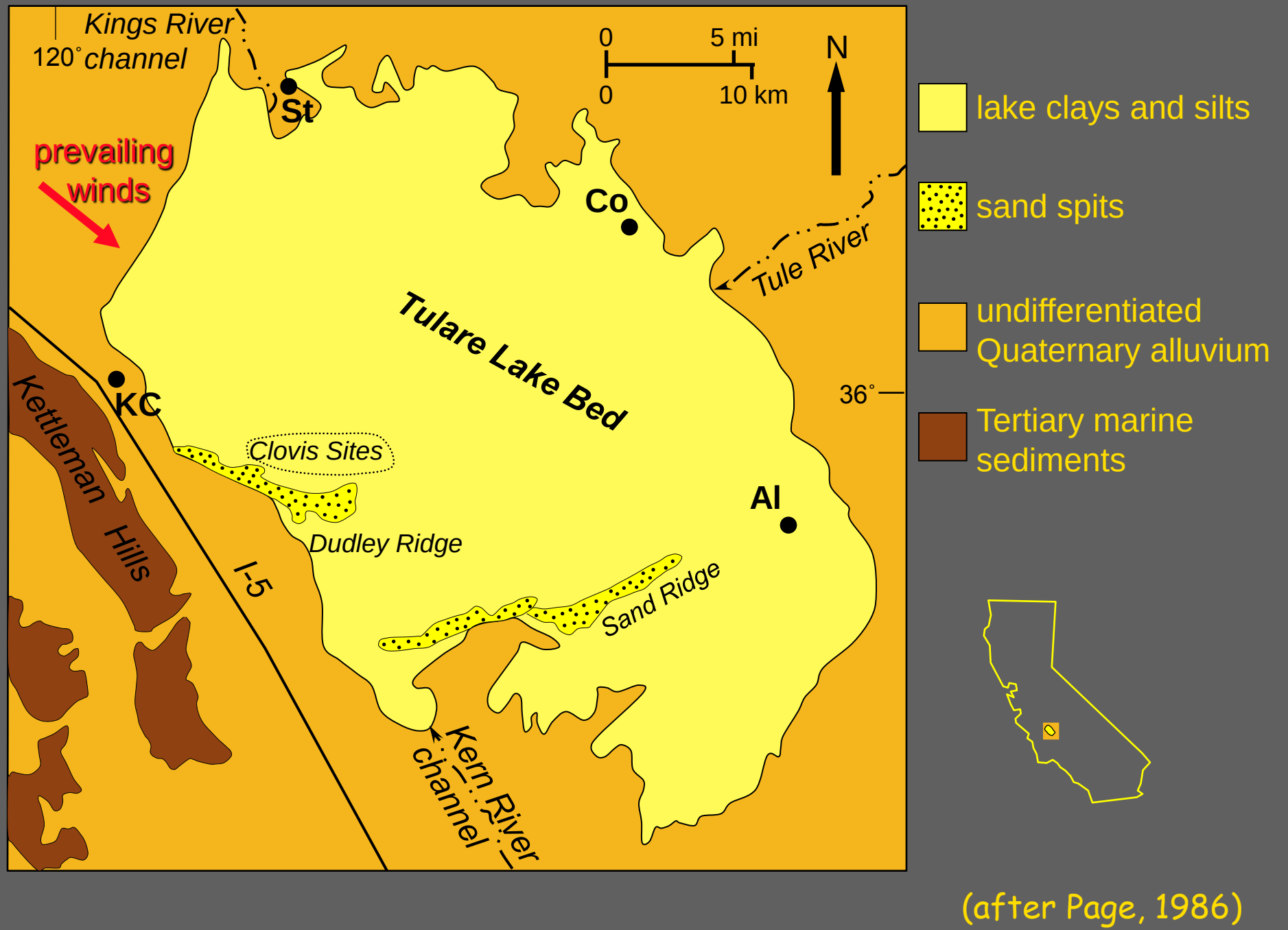
Lake-level can be predicted with hydrologic balance model based principally on runoff

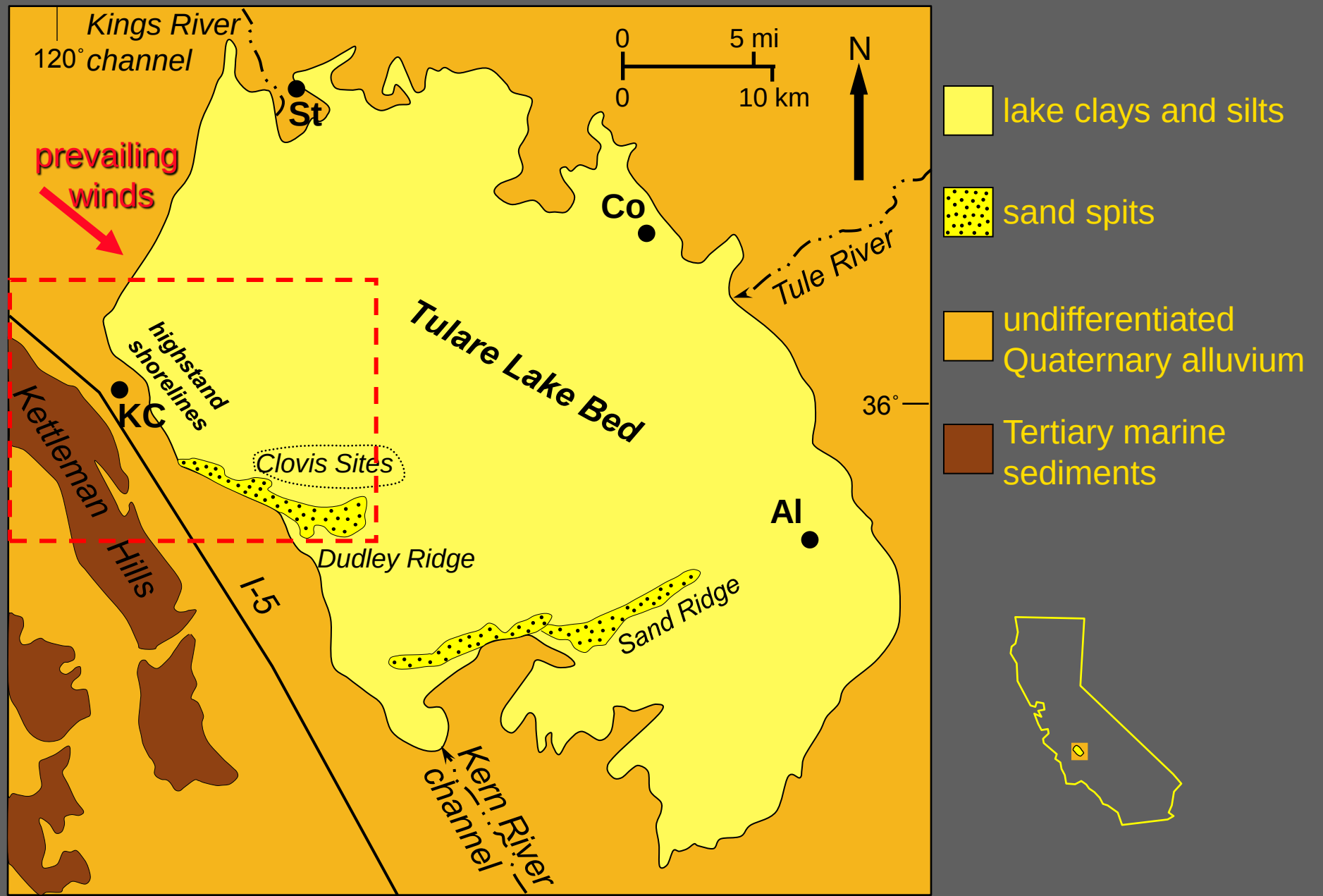


Atwater et al. (1986)

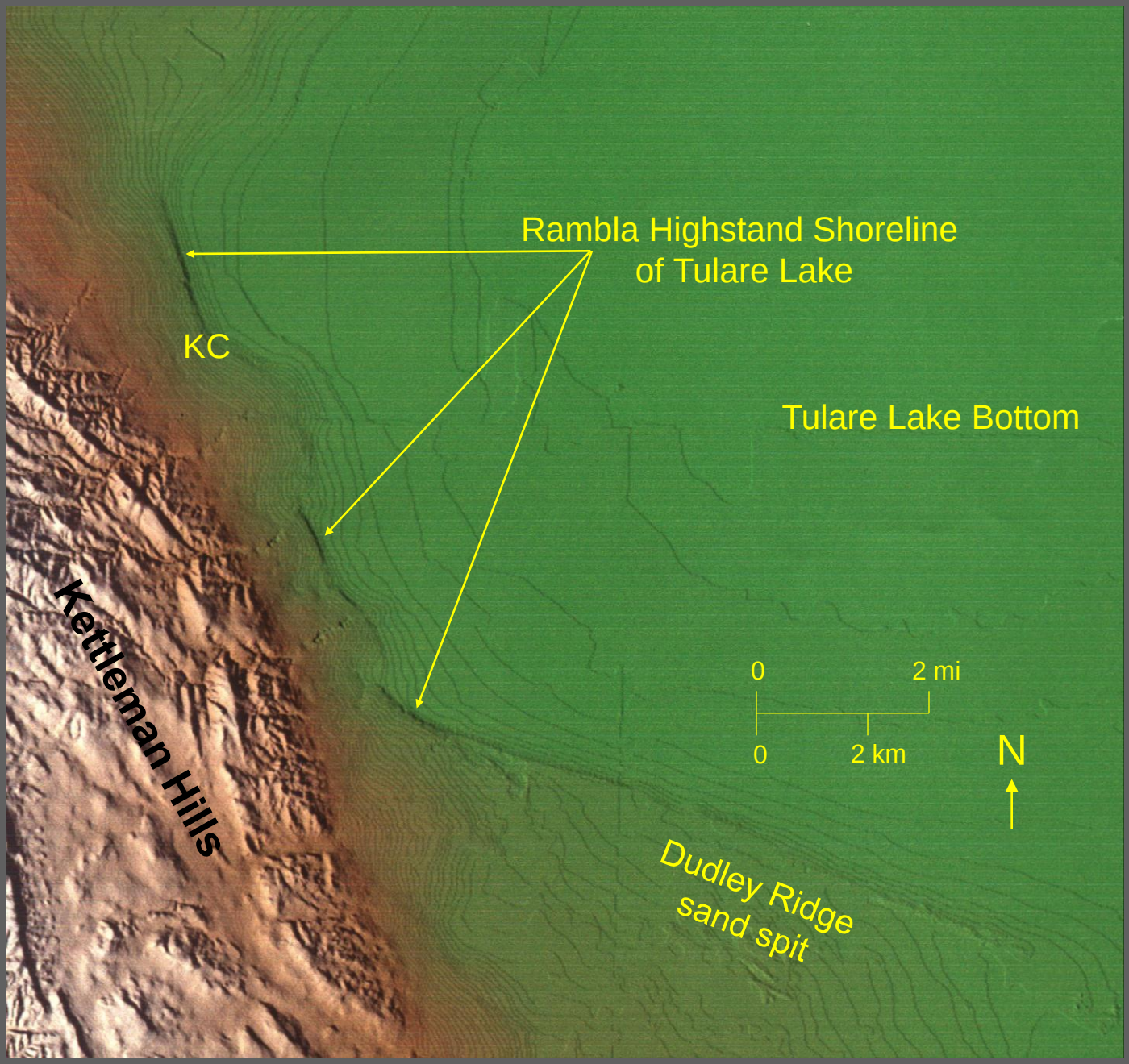
So, runoff can be reconstructed using lake-level



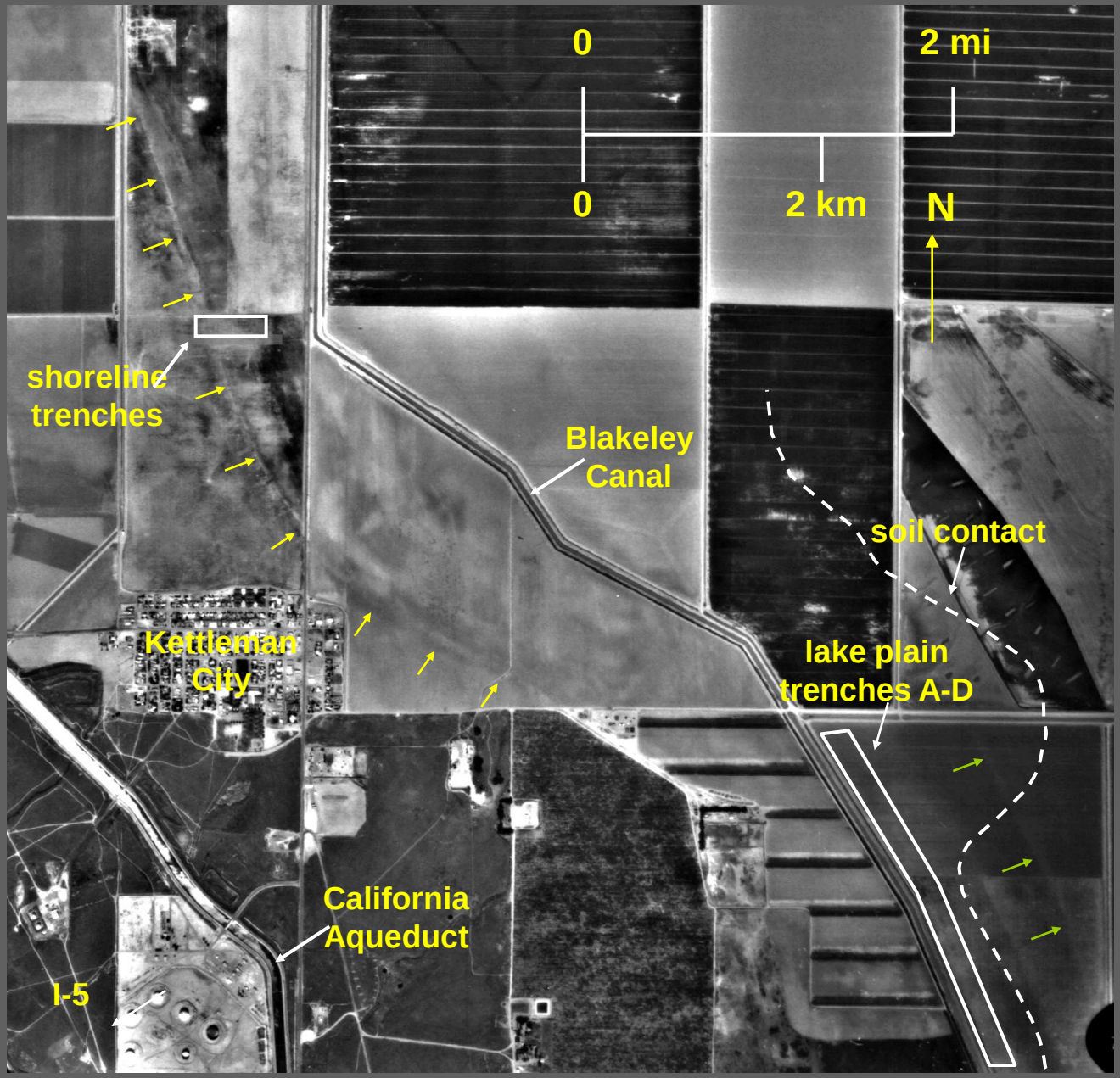

Kings River
120˚ channel
St
prevailing winds
0
5 mi
0
10 km
N
Co
Tule River
Tulare Lake Bed
KC
36˚
Kettleman Hills
Clovis Sites
Al
Dudley Ridge
I-5
Sand Ridge
Kern River channel
lake clays and silts
sand spits
undifferentiated Quaternary alluvium
Tertiary marine sediments
(after Page, 1986)

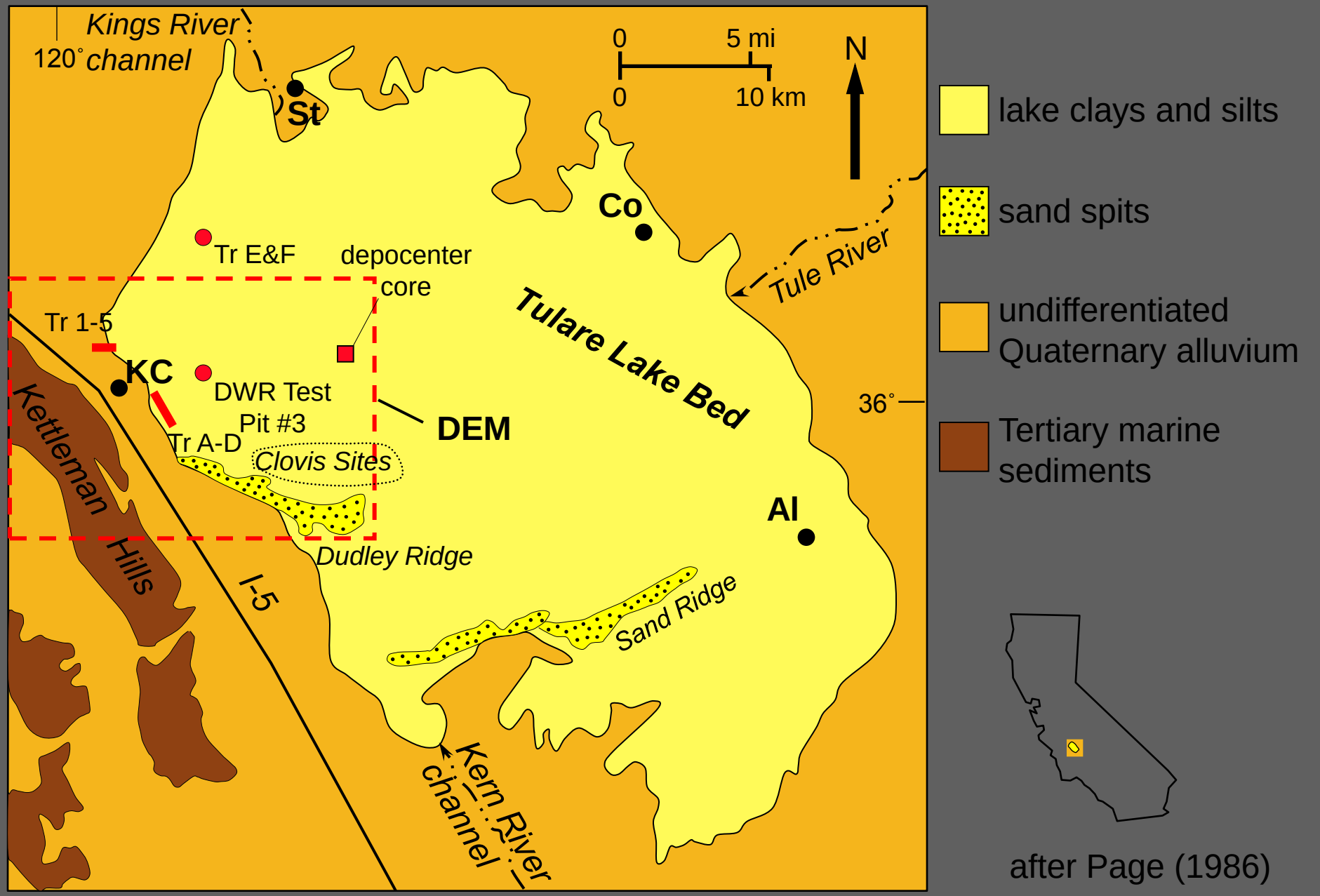


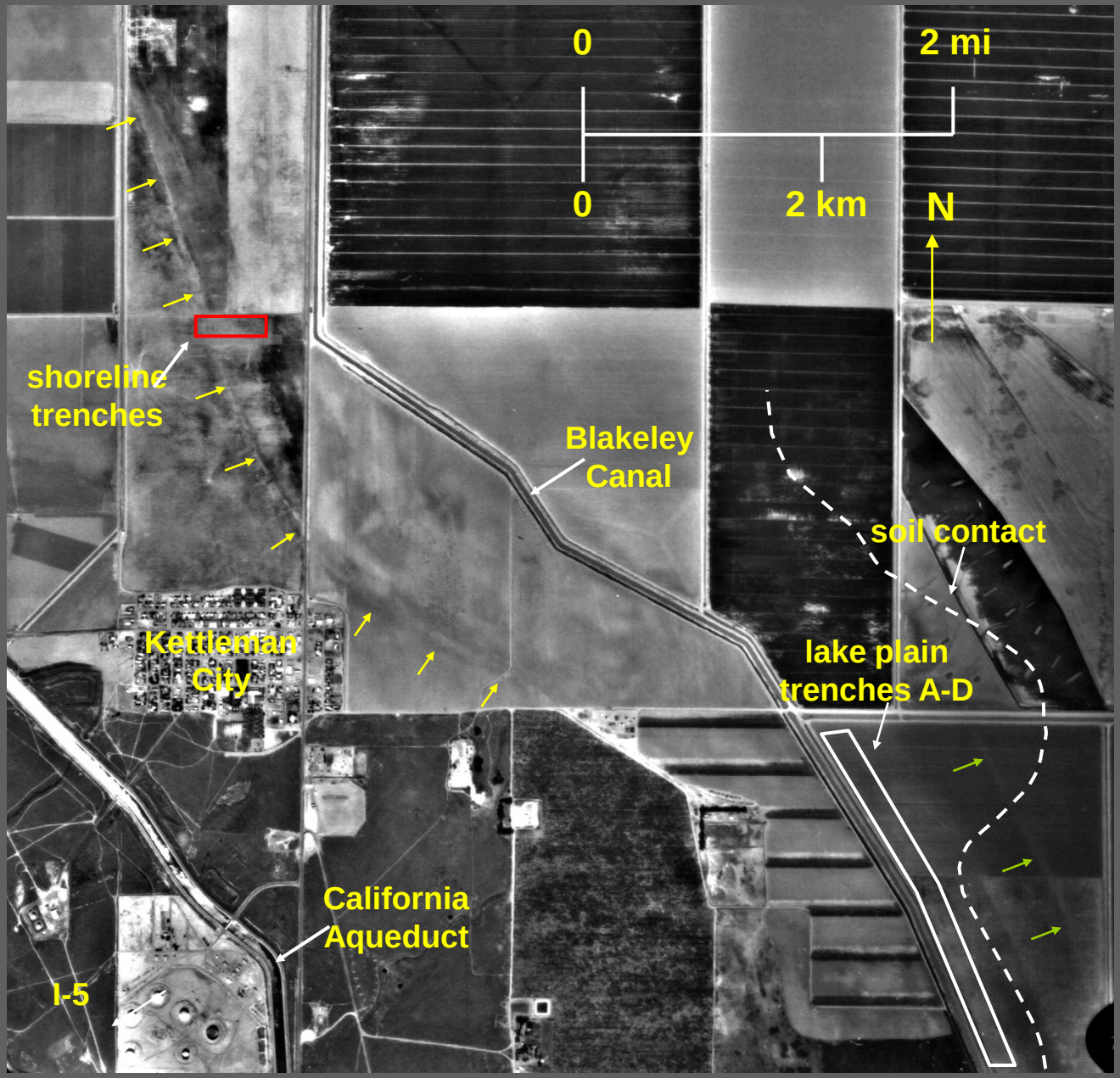
(after Page, 1986)


Rambla Highstand Shoreline
of Tulare Lake
KC
Tulare Lake Bottom
Kettleman Hills
0
2 mi
0
2 km
N
Dudley Ridge
sand spit

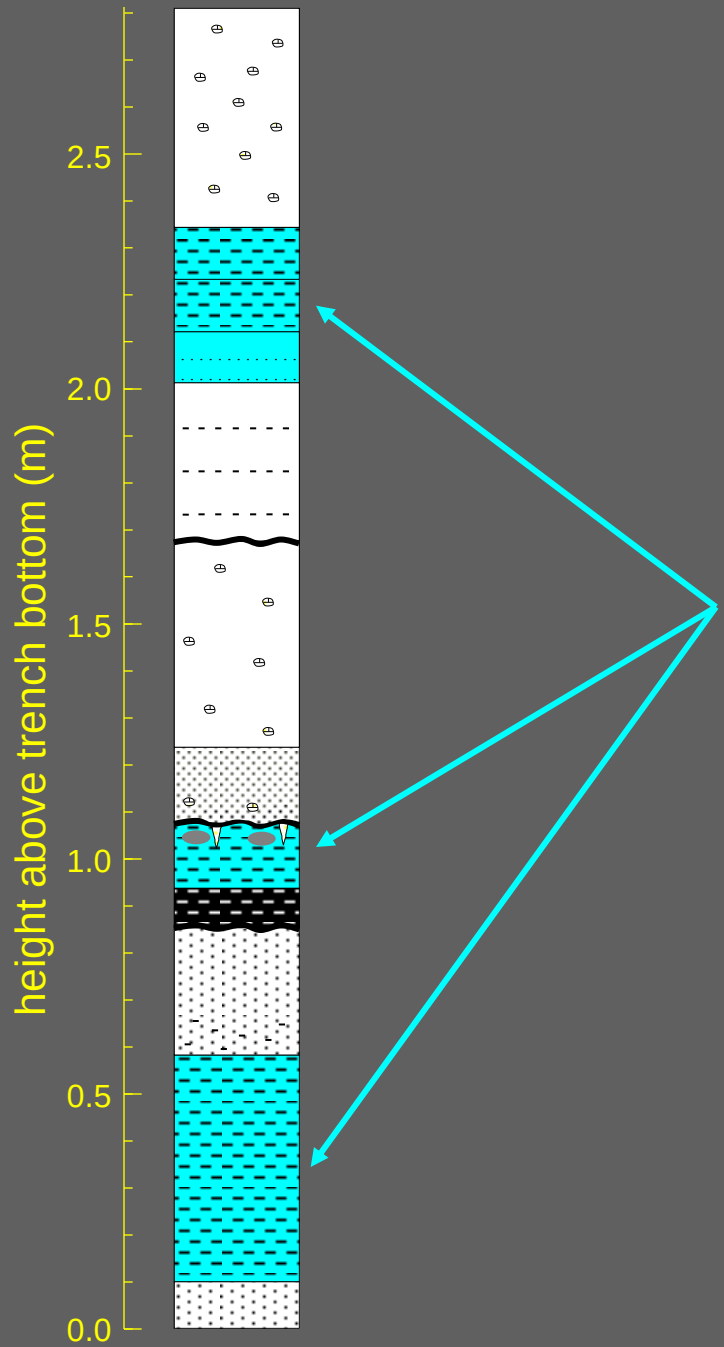
Tulare Lake Highstand Shoreline


0
2 mi
0
2 km
N
shoreline trenches
Blakeley Canal
soil contact
Kettleman City
lake plain trenches A-D
California Aqueduct
I-5

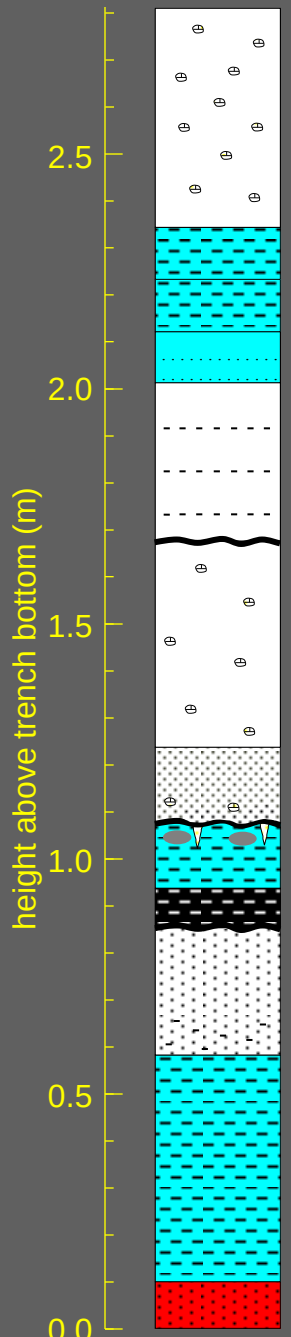

Kings River
120˚ channel
St
0
5 mi
0
10 km
N
Co
Tr E&F
depocenter
core
Tule River
Tr 1-5
KC
DWR Test
Pit #3
Tr A-D
DEM
Tulare Lake Bed
36˚
Clovis Sites
Kettleman Hills
I-5
Dudley Ridge
Al
Sand Ridge
Kern River
channel
lake clays and silts
sand spits
undifferentiated
Quaternary alluvium
Tertiary marine
sediments
after Page (1986)


0
2 mi
0
2 km
N
shoreline trenches
Blakeley Canal
soil contact
Kettleman City
lake plain trenches A-D
California Aqueduct
I-5

Shoreline Trench Stratigraphy

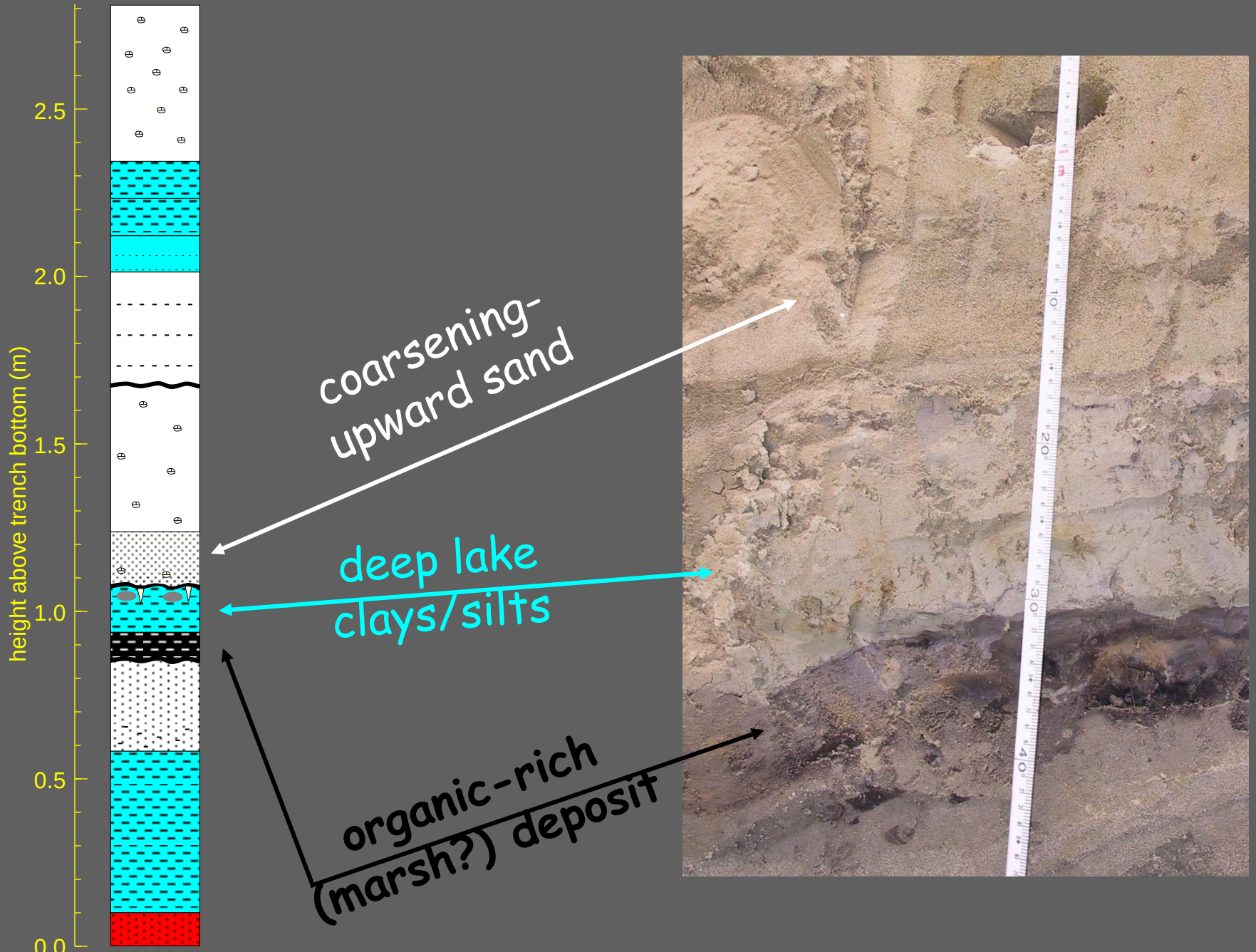


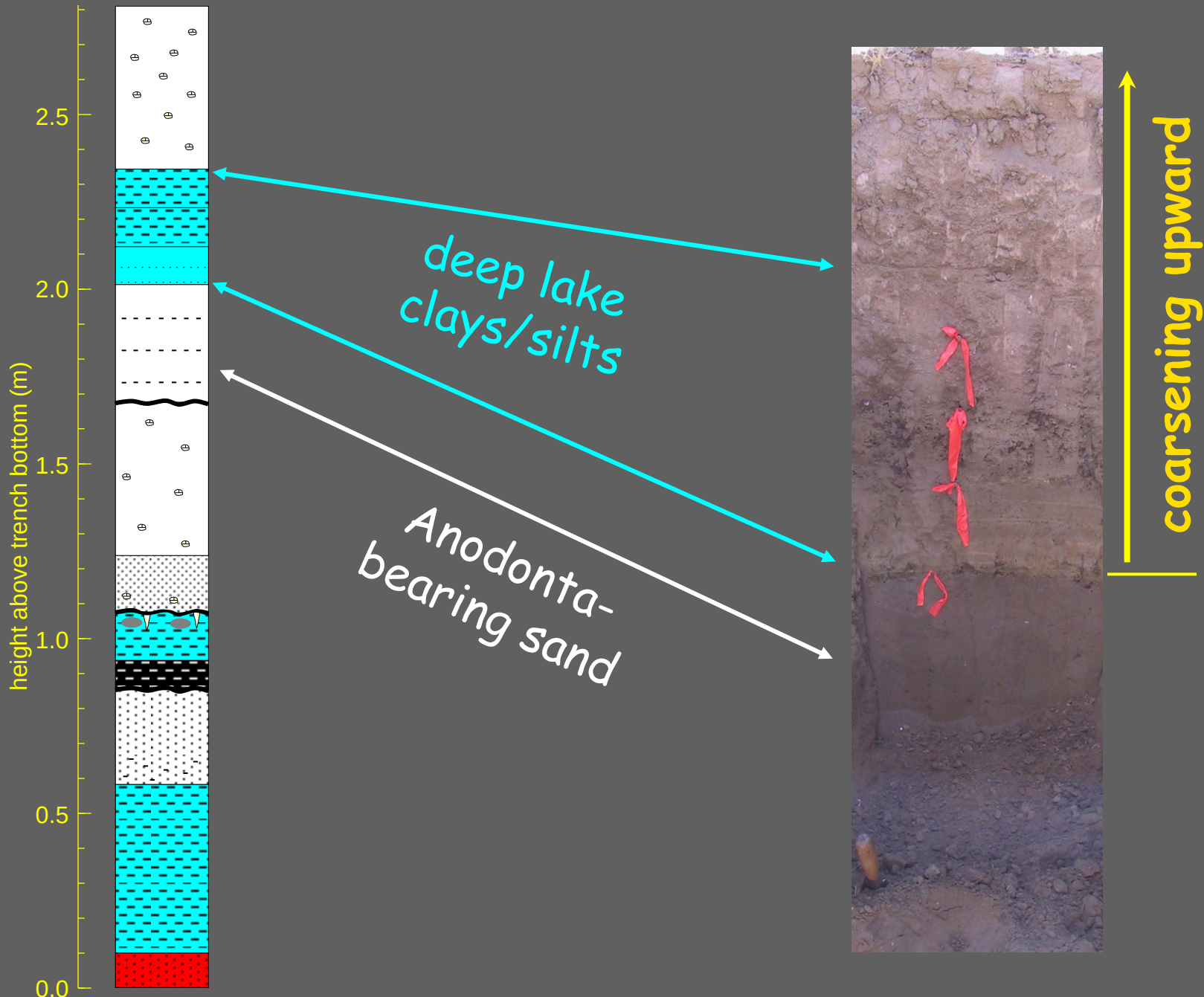
deep lake clays/silts



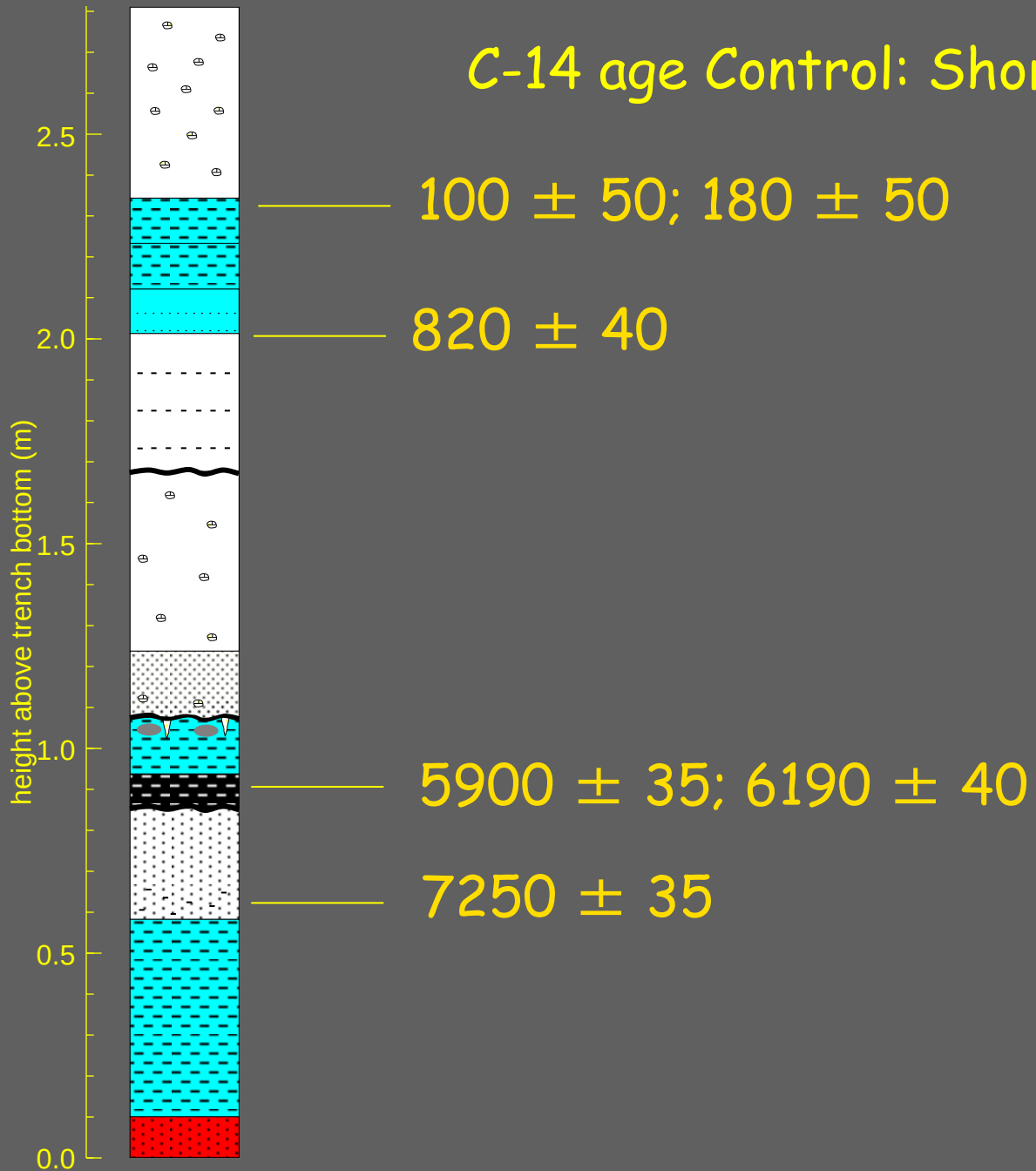
deep lake clays/silts

well-sorted beach(?) sand

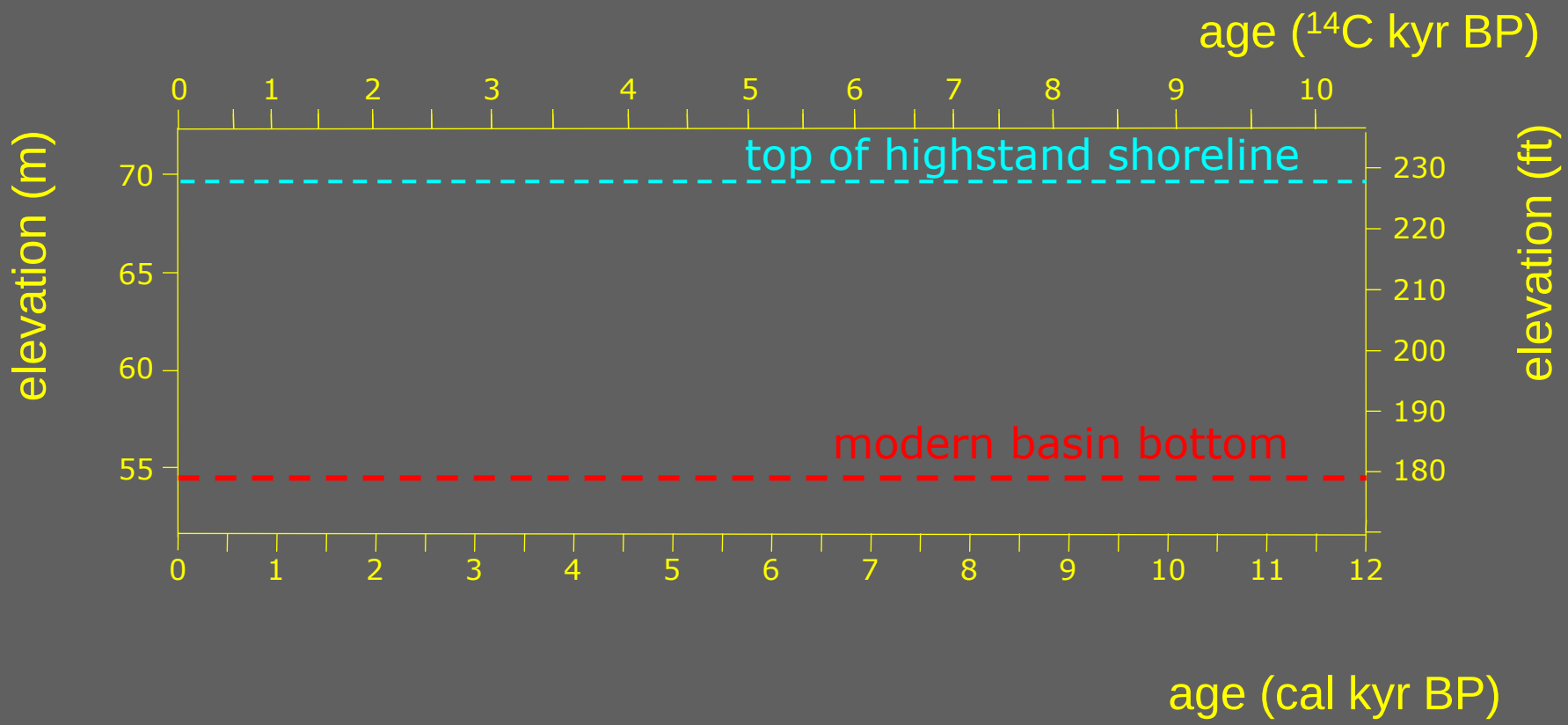

height above trench bottom (m)
2.5
2.0
1.5
1.0
0.5
0.0
coarsening-upward sand
deep lake clays/silts
organic-rich (marsh?) deposit


height above trench bottom (m)
2.5
2.0
1.5
1.0
0.5
0.0
deep lake clays/silts
Anodonta-bearing sand
coarsening upward

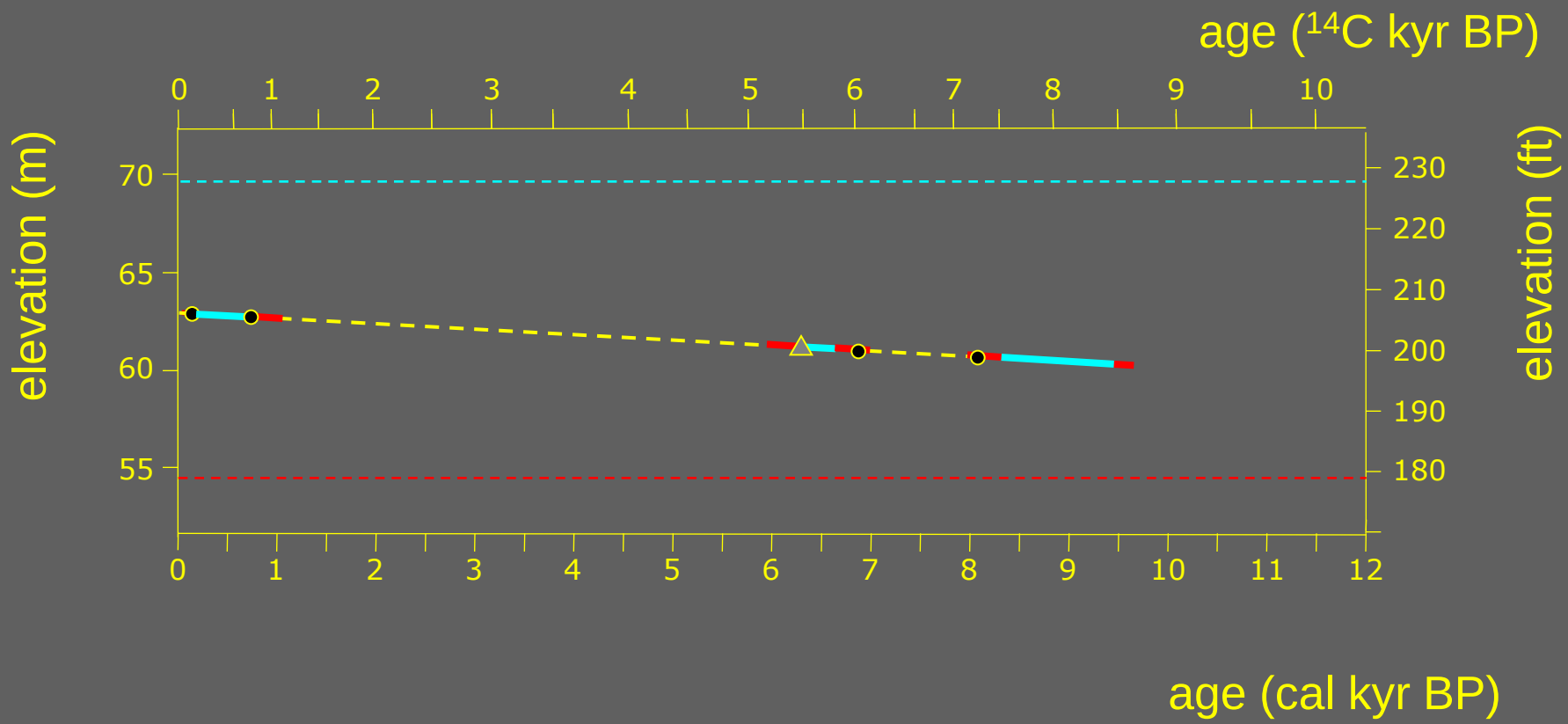
C-14 age Control: Shoreline Trenches



shoreline trench units



shoreline trench units

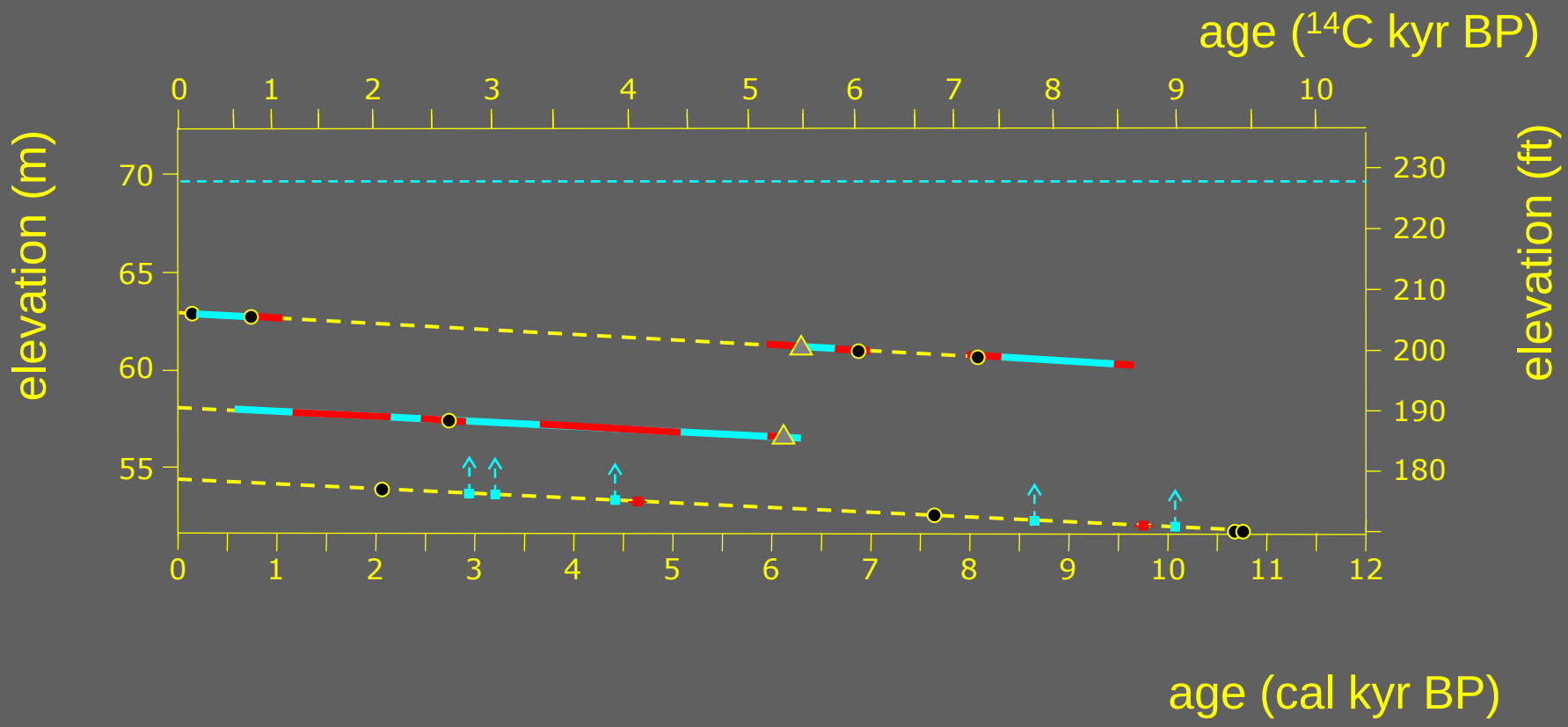


deep water deposits

^{14}C dates

shallow water deposits

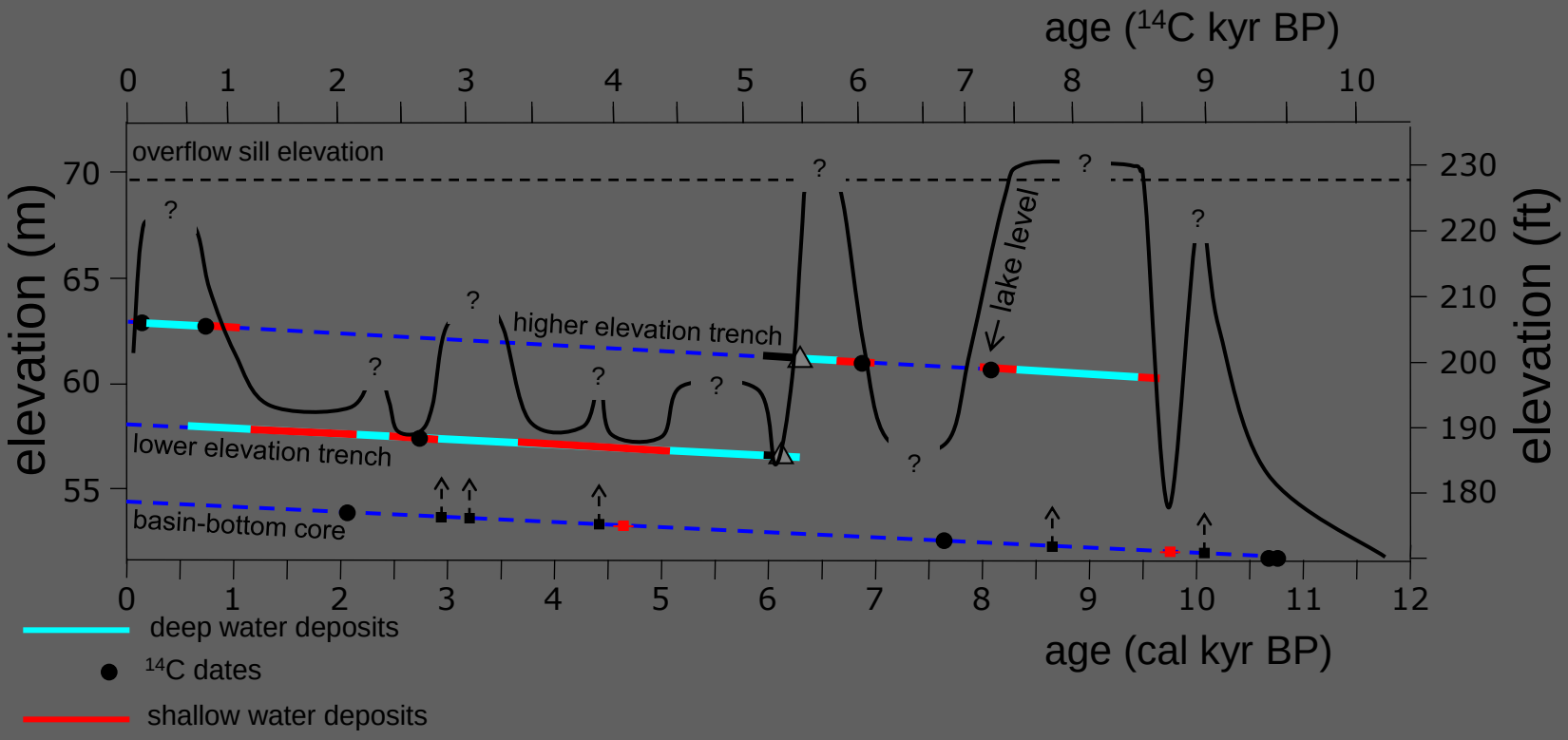
All Data

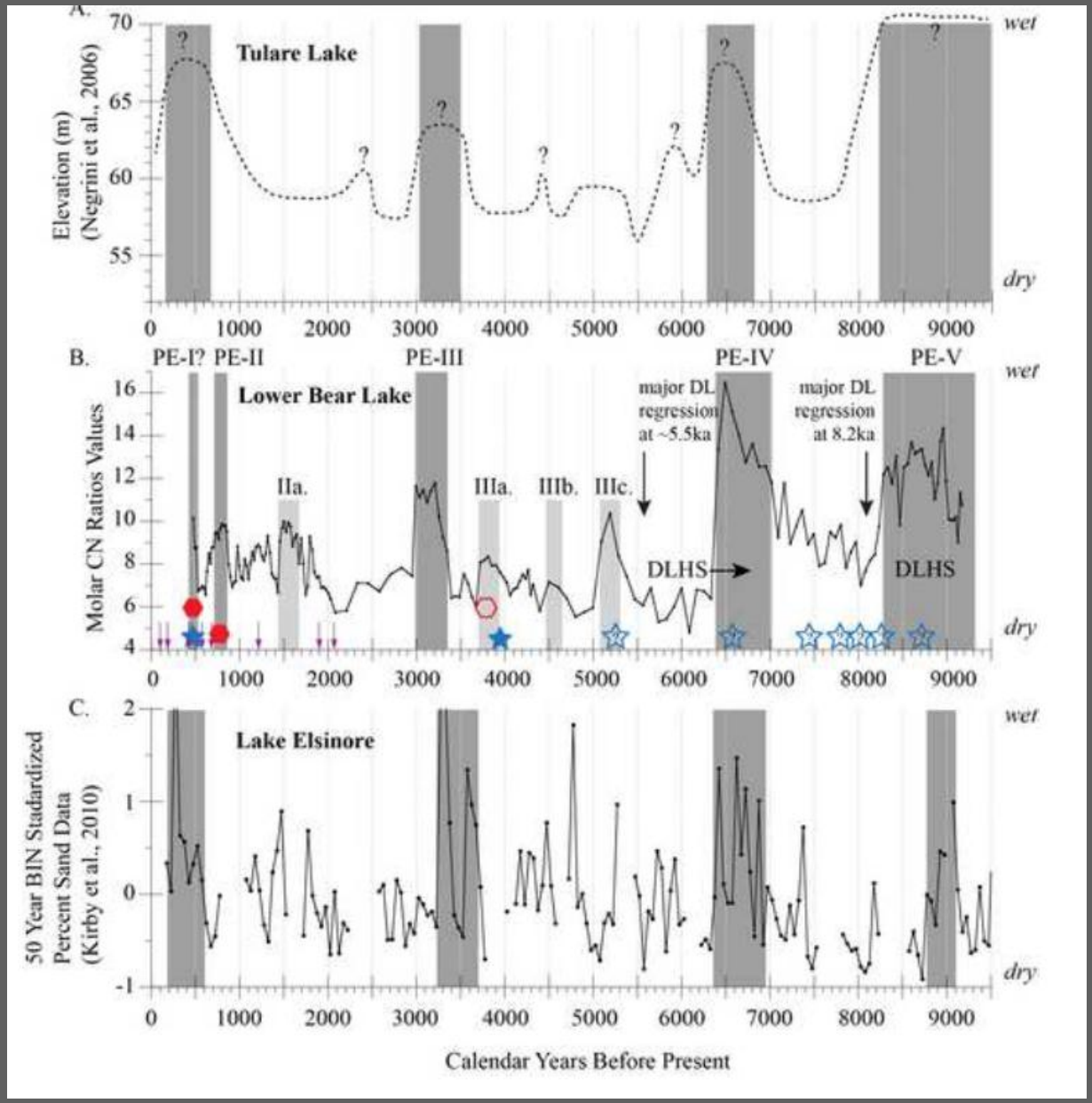


deep water deposits

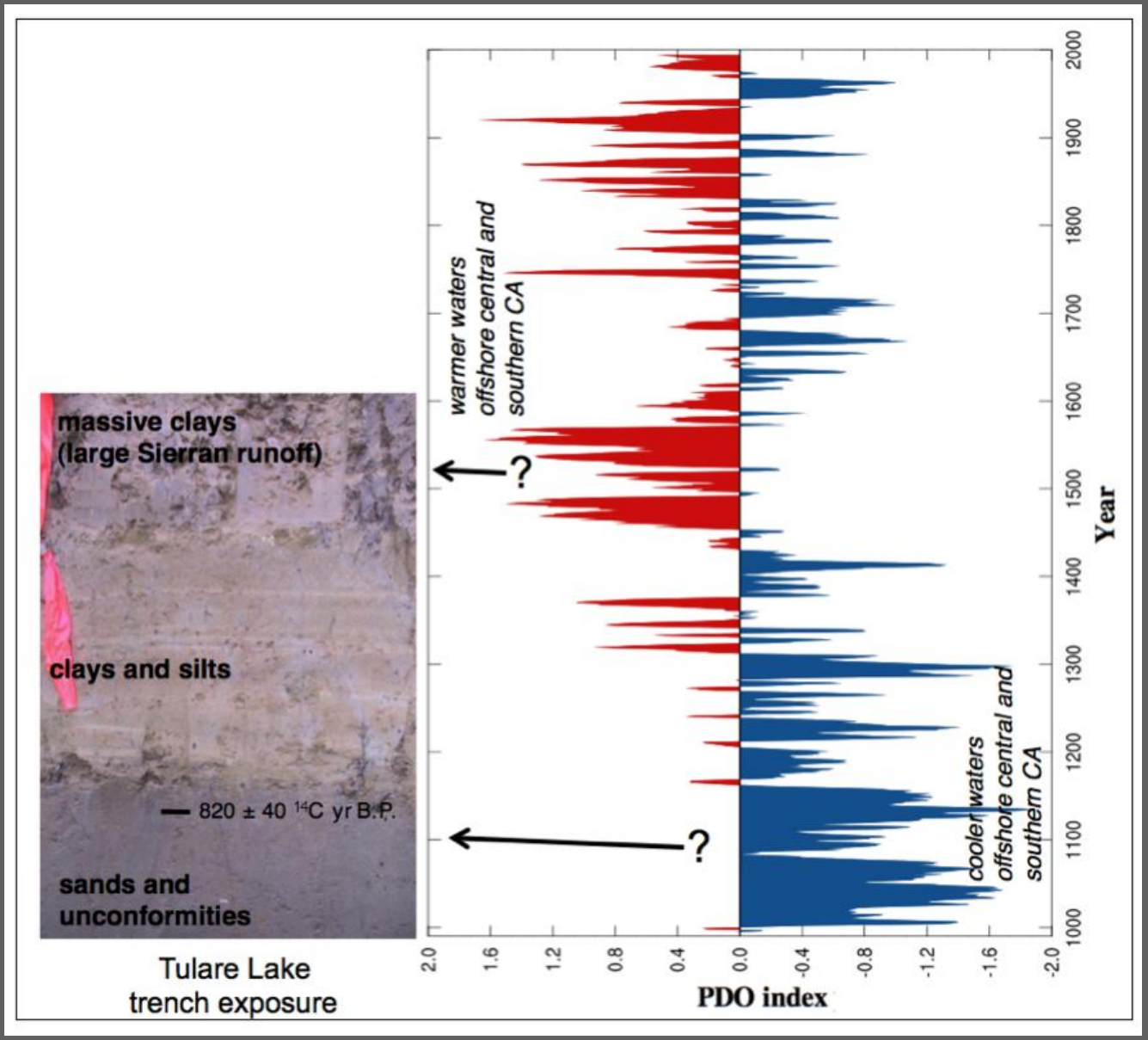
^{14}C dates

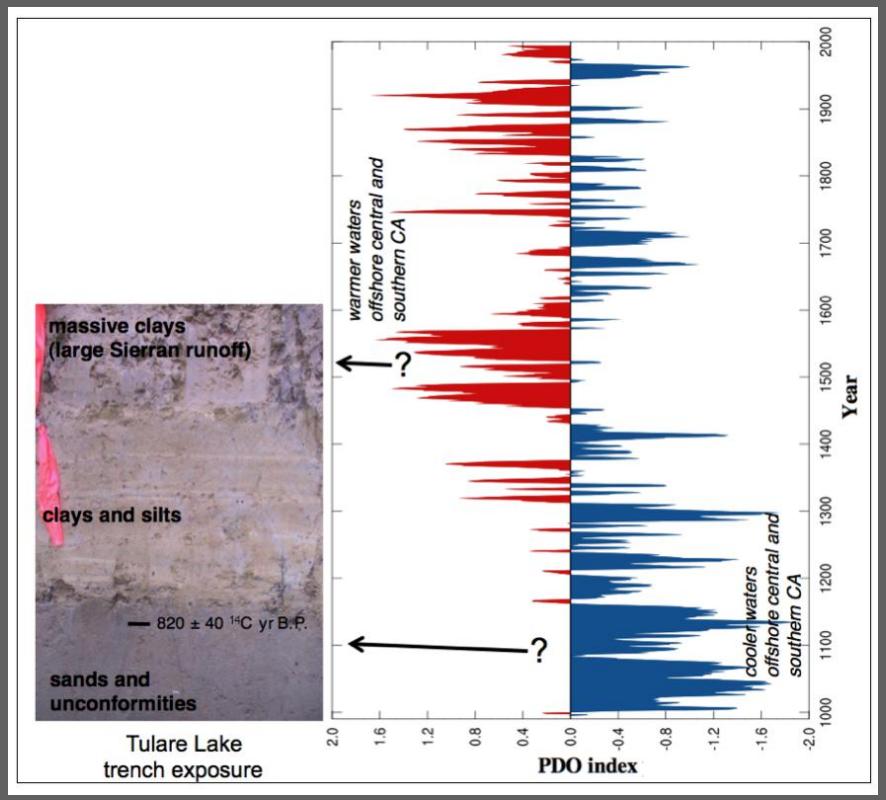
shallow water deposits

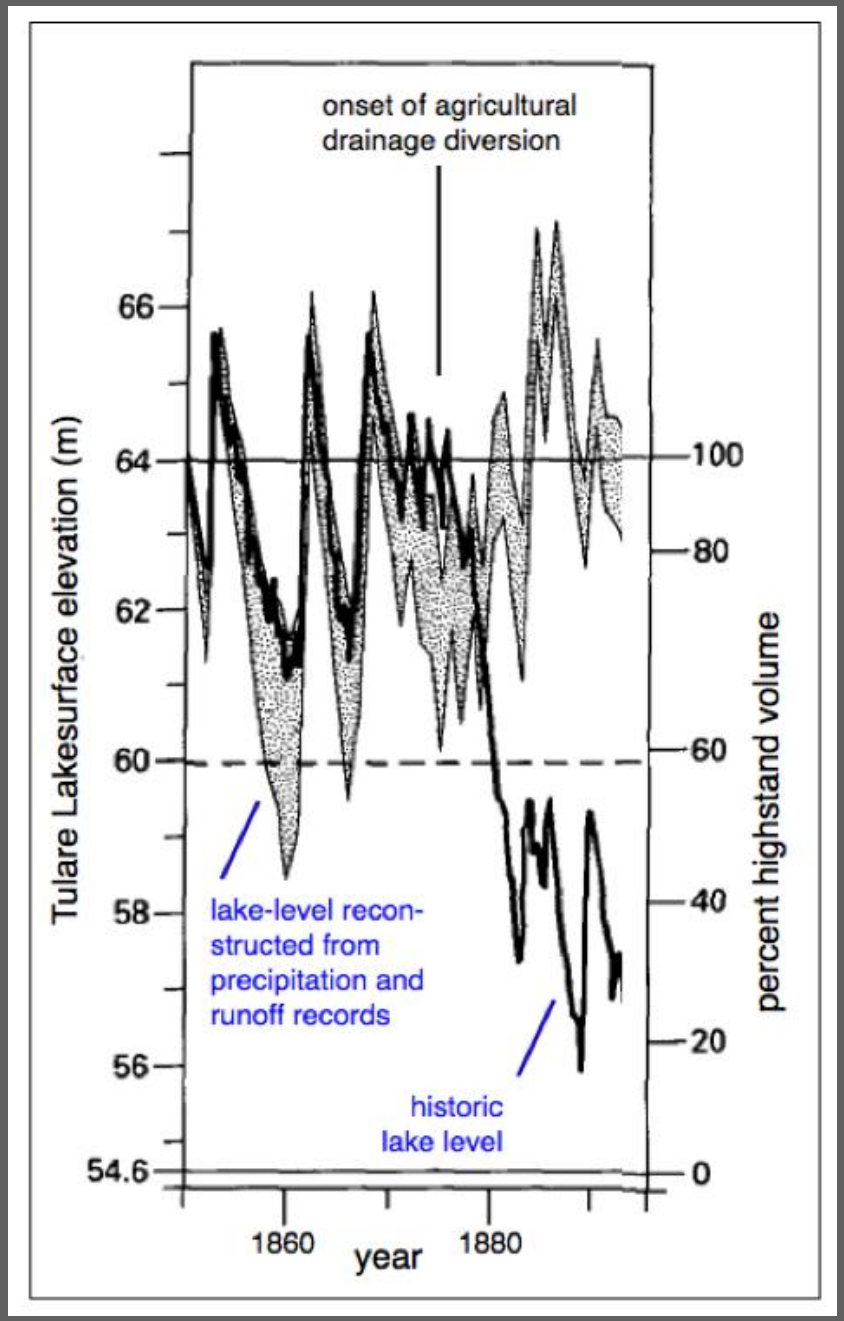

age (^{14}C kyr BP)
0 1 2 3 4 5 6 7 8 9 10
overflow sill elevation
70
65
60
55
elevation (m)
230
220
210
200
190
180
elevation (ft)
?
higher elevation trench
lower elevation trench
basin-bottom core
lake level
0 1 2 3 4 5 6 7 8 9 10 11 12
age (cal kyr BP)
deep water deposits
^{14}C dates
shallow water deposits

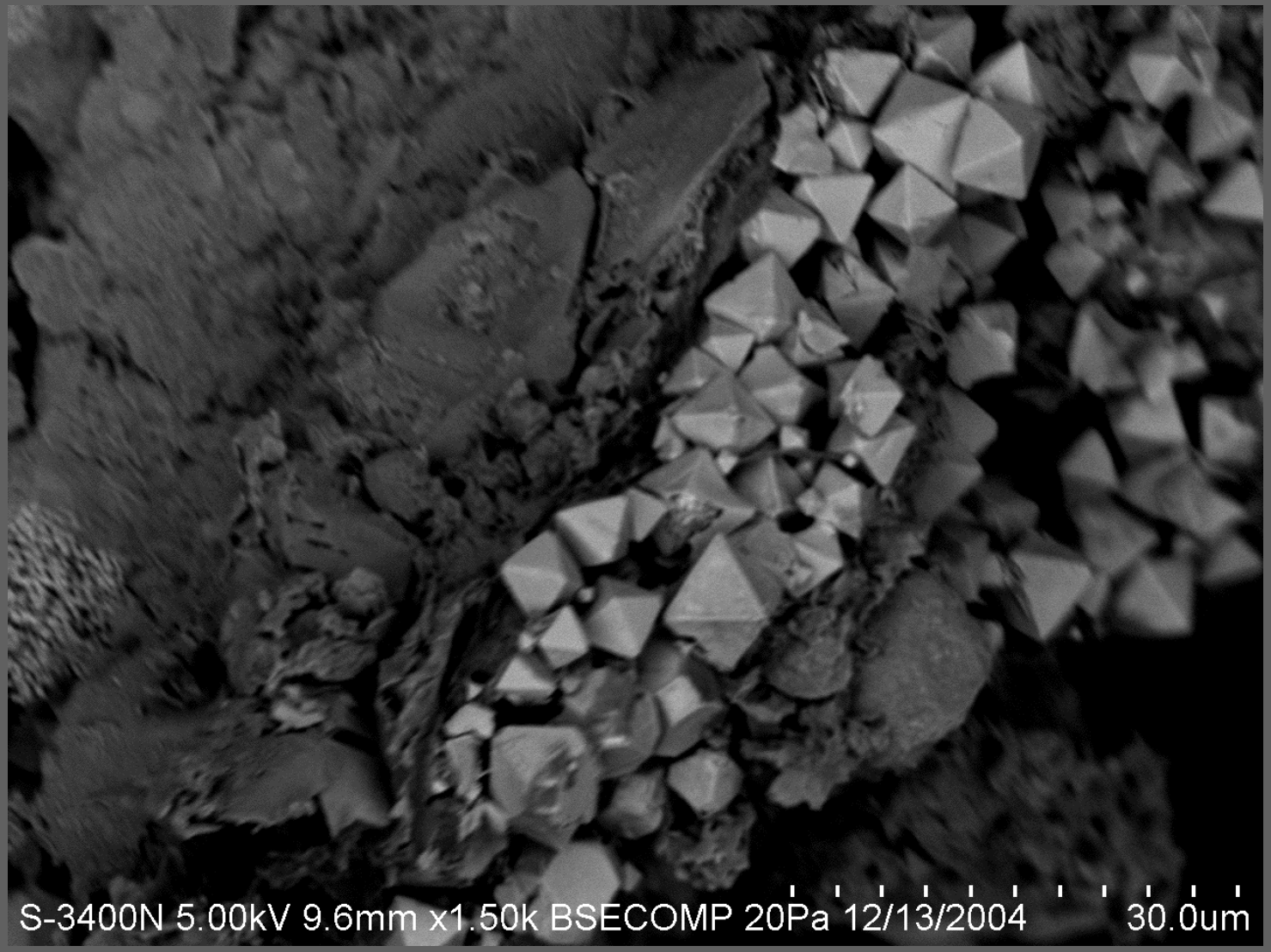


Kirby et al. (in press)

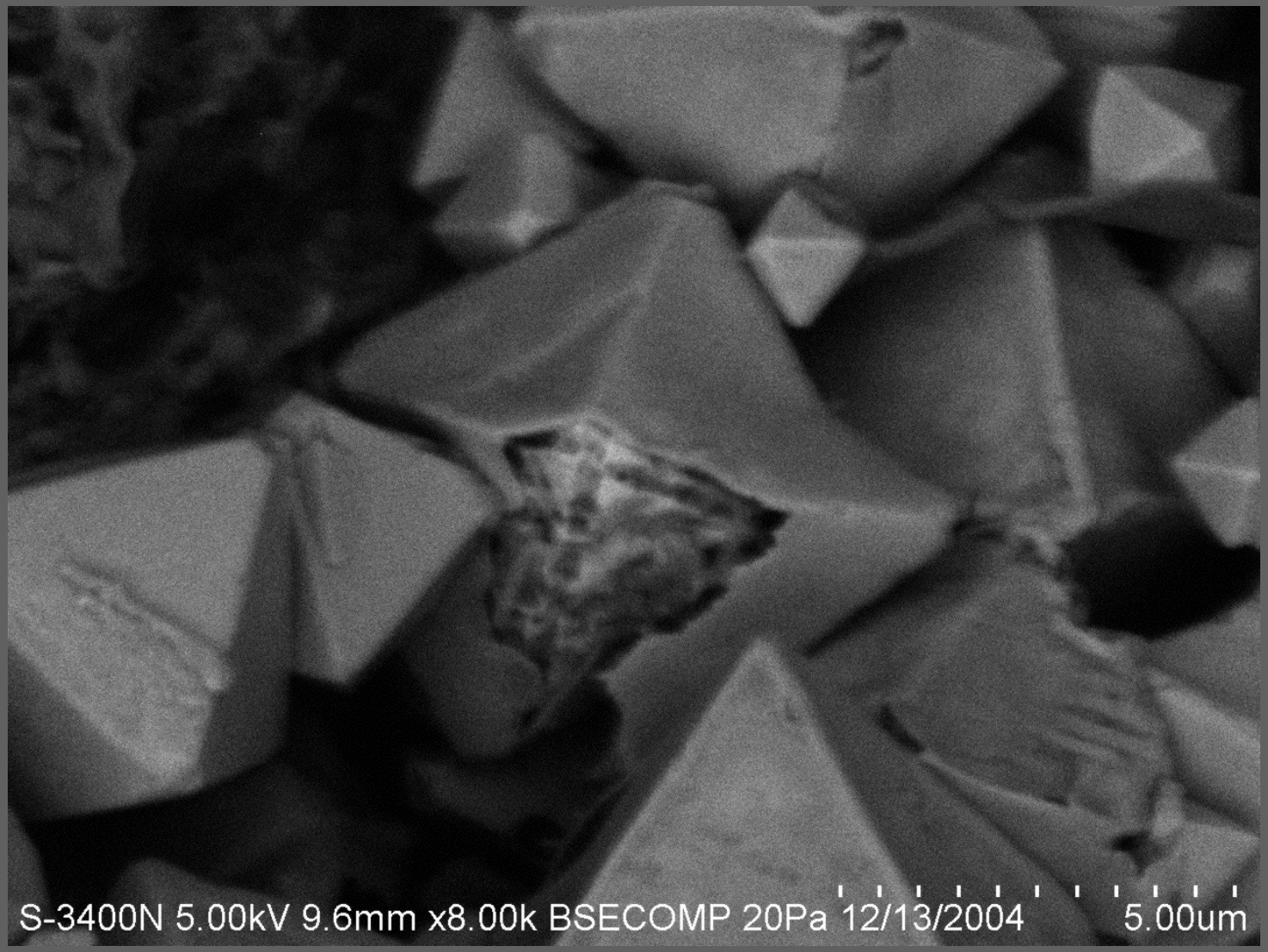

massive clays
(large Sierran runoff)
clays and silts
820 ± 40 14C yr B.P.
sands and
unconformities
Tulare Lake
trench exposure
warmer waters
offshore central and
southern CA
?
?
cooler waters
offshore central and
southern CA
PDO index
Year
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
-0.8
-1.2
-1.6
-2.0
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000


massive clays
(large Sierran runoff)
clays and silts
820 ± 40 14C yr B.P.
sands and
unconformities
Tulare Lake
trench exposure
warmer waters
offshore central and
southern CA
?
?
cooler waters
offshore central and
southern CA
PDO index
Year

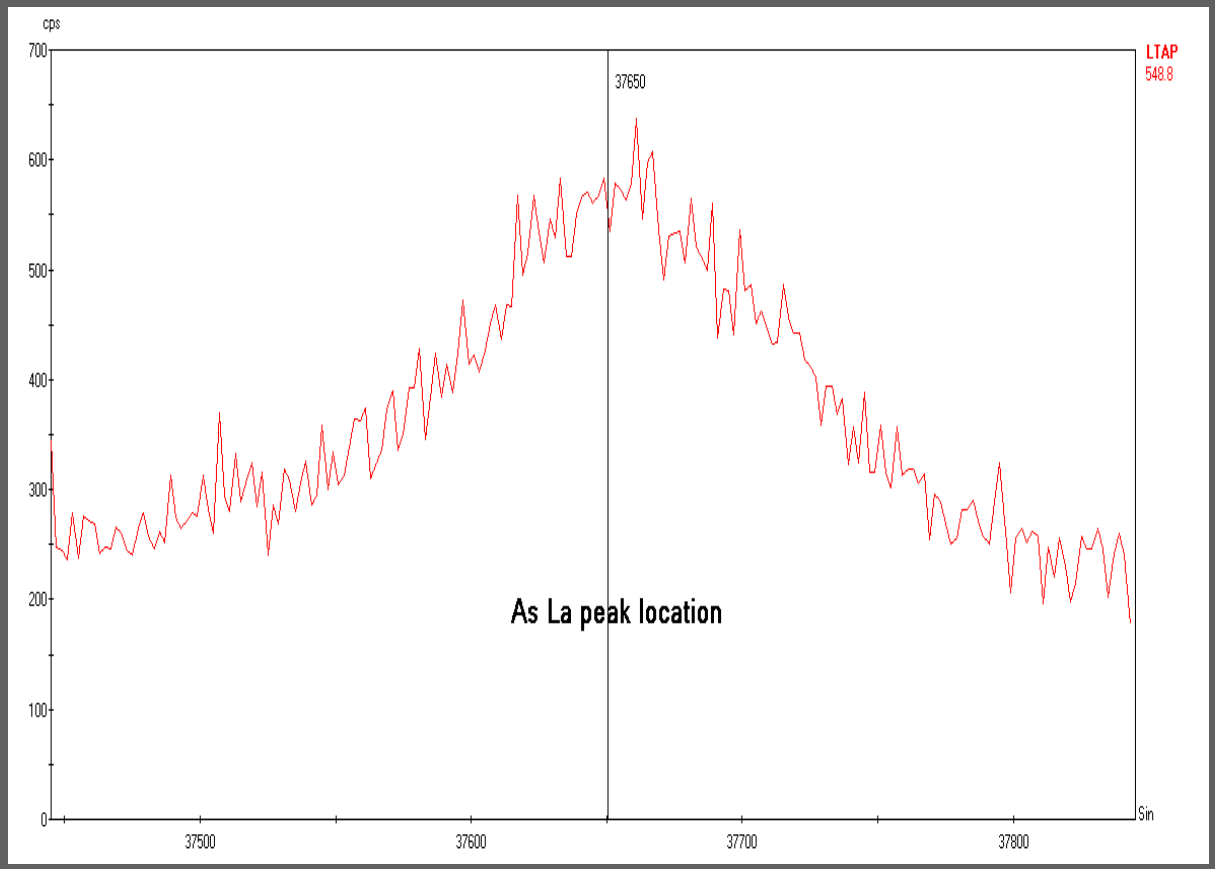

onset of agricultural
drainage diversion
Tulare Lakesurface elevation (m)
percent highstand volume
lake-level recon-
structed from
precipitation and
runoff records
historic
lake level
year
1860
1880
66
64
62
60
58
56
54.6
100
80
60
40
20
0



Authigenic pyrite crystals in shale (grain mount). SEM backscattered-electron image. Well 23H, depth = 550 ft.



Close-up view of authigenic pyrite crystals in shale showing dissolution textures (grain mount). SEM backscattered- electron image. Well 23H, depth =



WDS spectrum of pyrite in framboidal spherule showing distinct La peak for arsenic. Depth = 690 ft.

Electron-microprobe analysis of pyrites

SAMPLE DESCRIPTION	Wt% S	Wt% Fe	Wt% As	Wt% Al	Wt% Si	Wt% Total
Standard	53.5243	46.5209	-0.001	-0.0009	0.0123	100.0575
Standard	53.6546	46.2842	0.012	0.0058	0.0223	99.9788
23H-780 framboid D	52.0127	44.6197	0.118	0.0725	0.0917	96.9153
23H-690 framboid c point 1	51.4348	44.8694	0.365	0.0029	0.0304	96.7026
23H-690 framboid c point 2	51.6776	45.0822	0.351	0.0068	0.0129	97.131
23H-690 spongy texture pyrite d point 1	51.8233	44.0877	0.092	0.0058	0.0721	96.0818
23H-690 spongy texture pyrite d point 2	48.9509	43.4345	0.097	0.0857	0.0776	92.6461
23H-690 framboid e point 1	51.675	45.4565	0.118	0.0149	0.0012	97.2661
23H-690 framboid e point 2	47.6734	45.2968	0.177	0.0183	0.0517	93.2181
23H-690 edge of big grain	51.189	44.0642	0.074	0.0206	0.0225	95.3706
23H-690 framboid f	51.7888	44.6561	0.155	0.0202	0.0301	96.6504
23H-690 framboid h	49.1612	44.6257	0.057	0.1211	0.2381	94.204

Pyrites contain up to 0.37% of Arsenic

Acknowledgements

- **Lorelea Samano, Matt Wigand, John Huff**
- **CA DWR (Janis Offerman, Jeff VanGilder, Bob Orlins)**
- **Kerry Arroues (USDA-Soil Conservation Service)**
- **NSF GeoDiversity Program (OTHR0303324)**
- **USGS Earth Surface Dynamics Program**
- **Westlake Farms**