THE GEOLOGY OF THE CARRIZO PLAIN NATIONAL MONUMENT AND ITS SURROUNDINGS

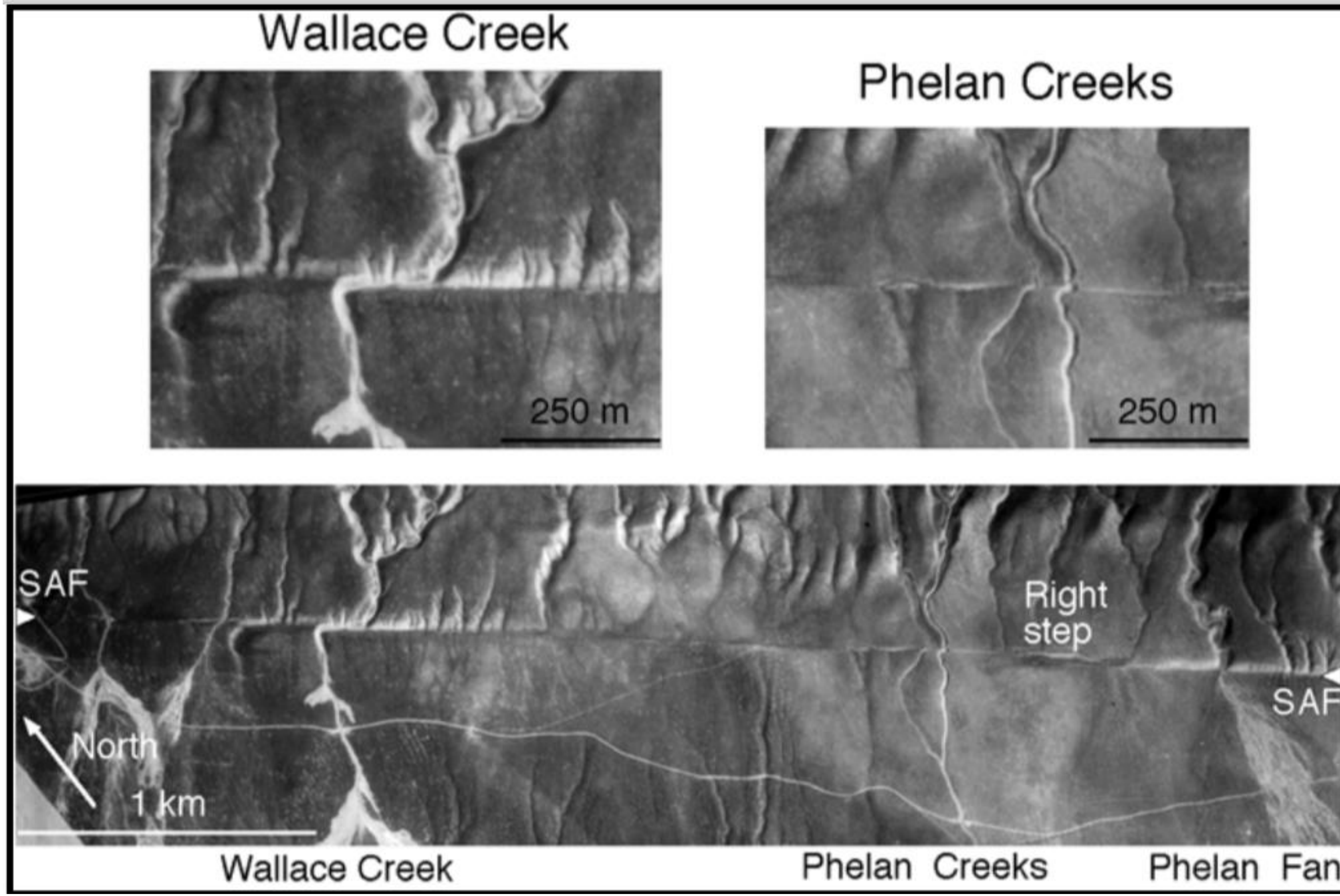
DAVID H. CHIPPING
FRIENDS OF THE CARRIZO PLAIN

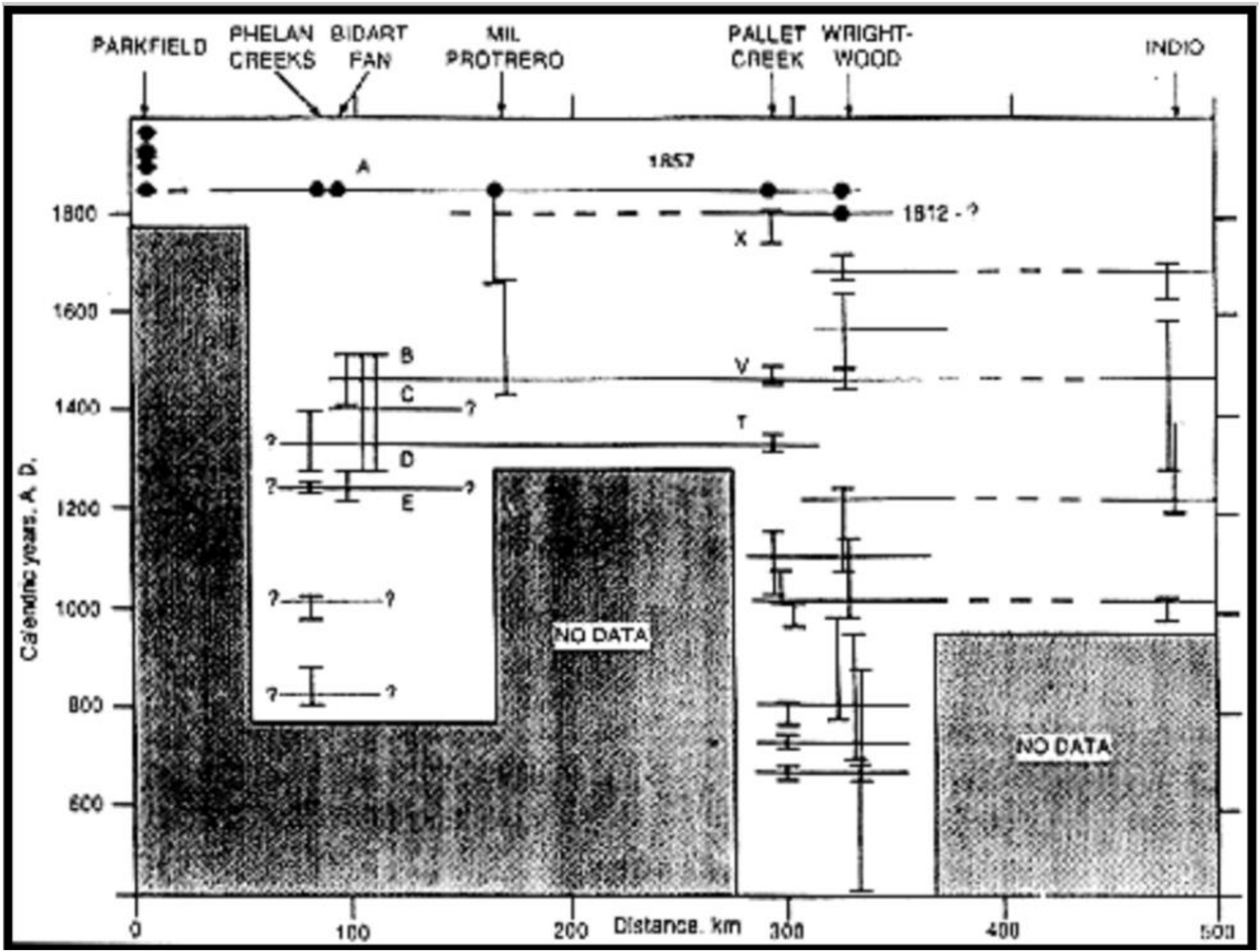
and now, the actual presentation…

RELATIVELY RECENT GEOLOGICAL
RESEARCH ON THE CARRIZO PLAIN

Part 1Seismic History

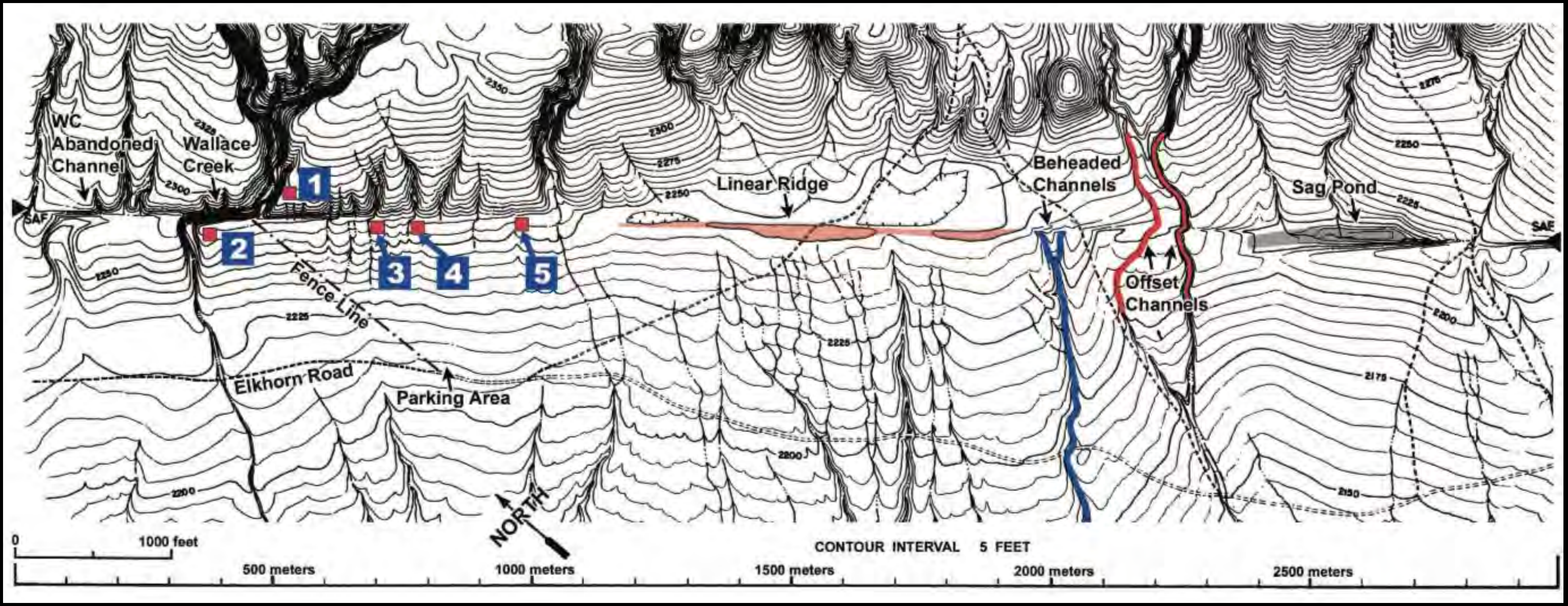
Details from the trace of the San Andreas Fault
(a) Trenching across the fault


Wallace Creek
Phelan Creeks
250 m
250 m
SAF
Right step
SAF
North
1 km
Wallace Creek
Phelan Creeks
Phelan Fan



PARKFIELD
PHELAN CREEKS
BIDART FAN
MIL PROTRERO
PALLET CREEK
WRIGHT-WOOD
INDIO
A
1857
1812 - ?
X
B
C
V
T
D
E
NO DATA
NO DATA
Calendric years, A. D.
1800
1600
1400
1200
1000
800
600
0
100
200
300
400
500
Distance, km

Wallace Creek



After digging a series of trenches, geologists found that the youngest material in the older channel was about 3800 years old. The modern channel of Wallace Creek must have been cut just after the 3800-year-old material was deposited. Since Wallace Creek has been offset 420 feet (130 m) since then, the fault must be slipping at an average rate of about 1.3 inches (34 mm) per year.

Slip Rate on the San Andreas fault at Wallace Creek:

$$\frac{\text{offset}}{\text{time}} = \frac{420\text{ feet}}{3800\text{ years}} = \frac{5040\text{ inches}}{3800\text{ years}} = 1.3\text{ inches per year}$$

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Special Thanks to:
Michael Ayers (BLM)
Johna Hurl (BLM)
Kathy Sharum (BLM)
Larry Vredenburgh (BLM)

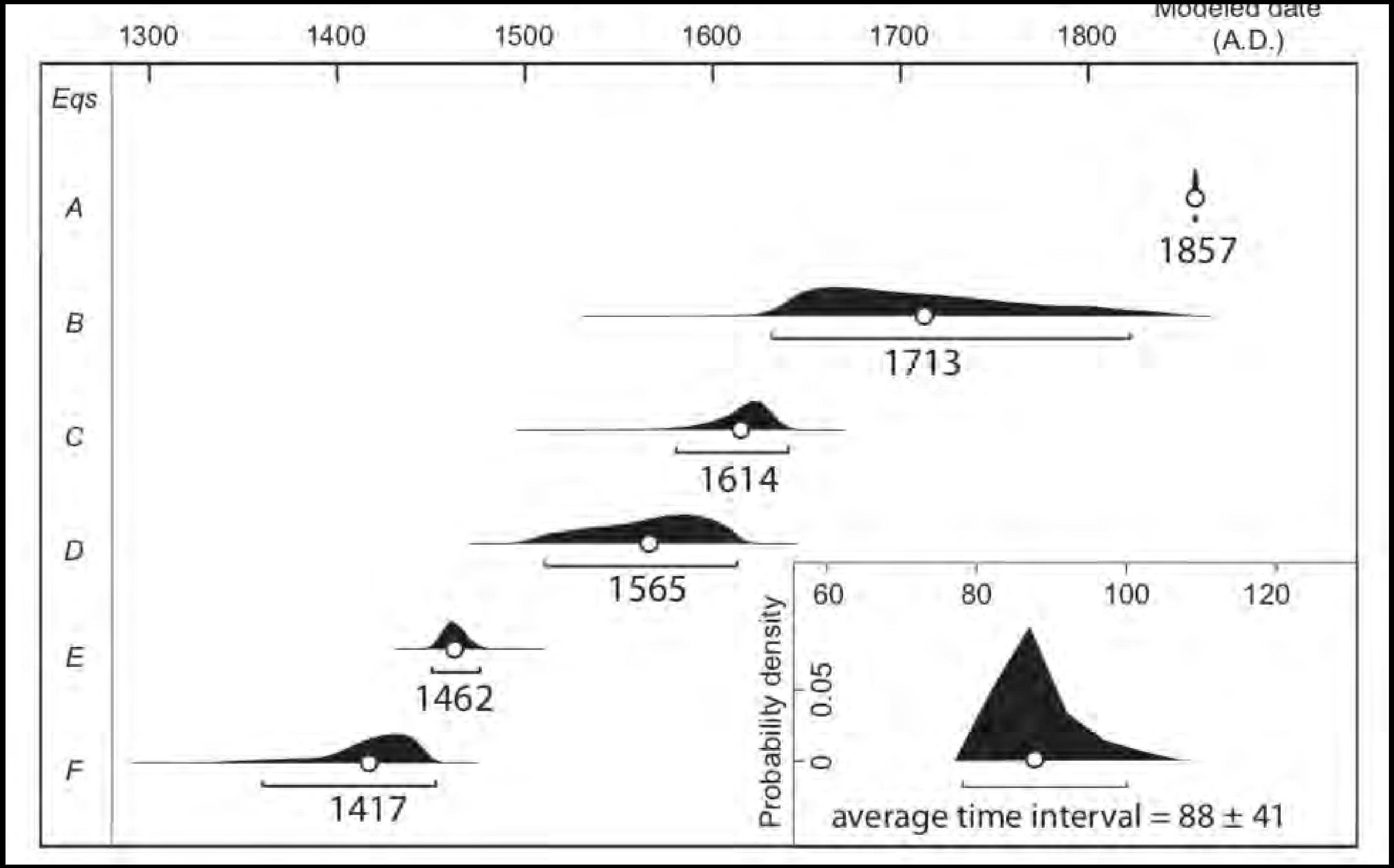
Acknowledgments:
The Wallace Creek map was adapted from K. Sieh and R. E. Wallace, "The San Andreas fault at Wallace Creek," in *Geological Society of America Centennial Field Guide, Cordilleran Section* (1987).
The map of California was adapted from K. Sieh and S. LeVay, *The Earth in Turmoil*, © 1998, W. H. Freeman and Company. The aerial photo is used courtesy of and with permission of G. Gerster.
The 3-D fault drawing (under "What is the San Andreas fault?") is adapted from a drawing by J. Marquis / SCEC. All channel sketches by A. Meltzner. Trail guide design by A. Meltzner and R. de Groot.

Additional copies of this trail guide and further information are available online at **http://www.scec.org/wallacecreek** or from the Bureau of Land Management, 3801 Pegasus Drive, Bakersfield, CA 93308.

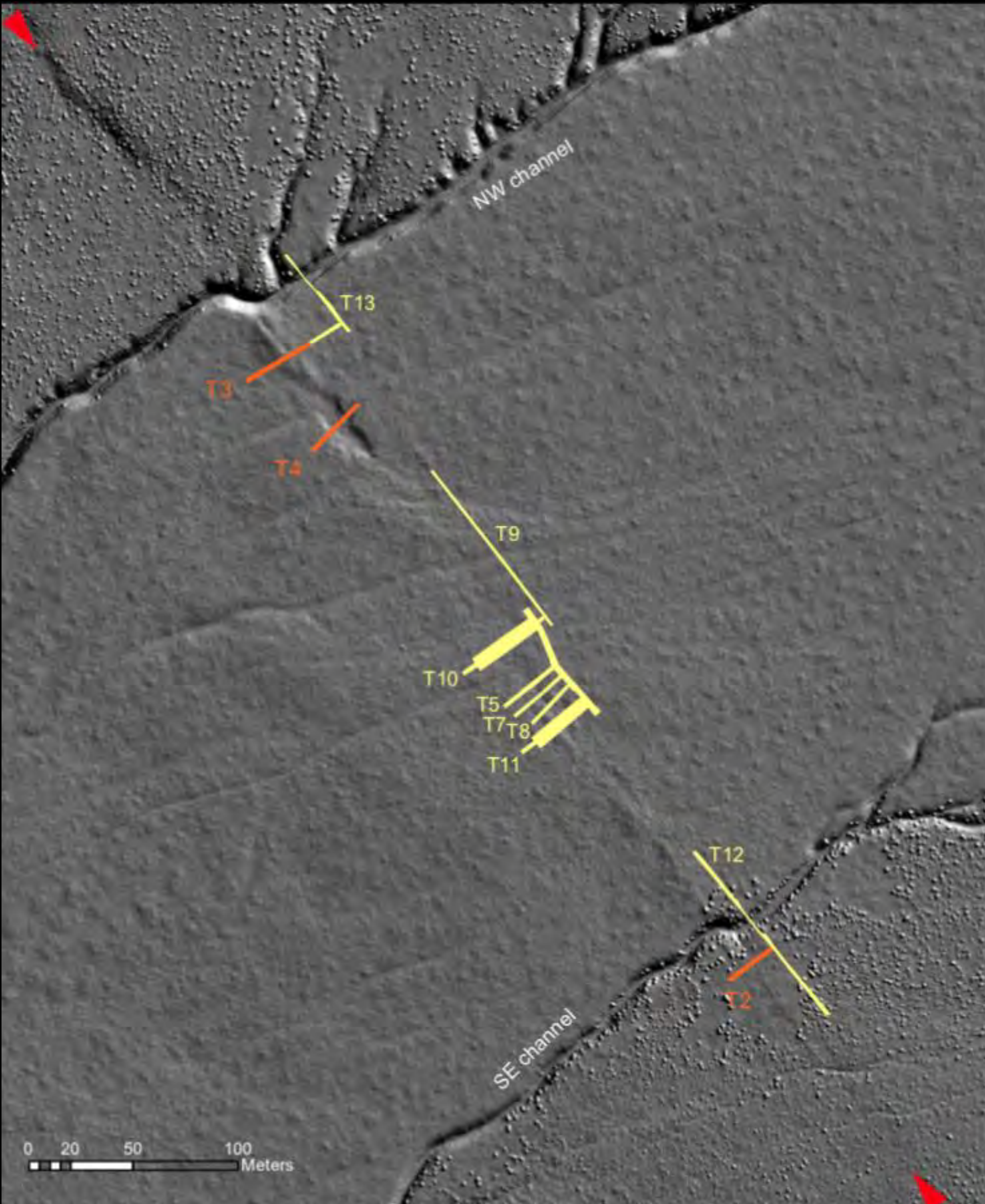
Bidart Fan

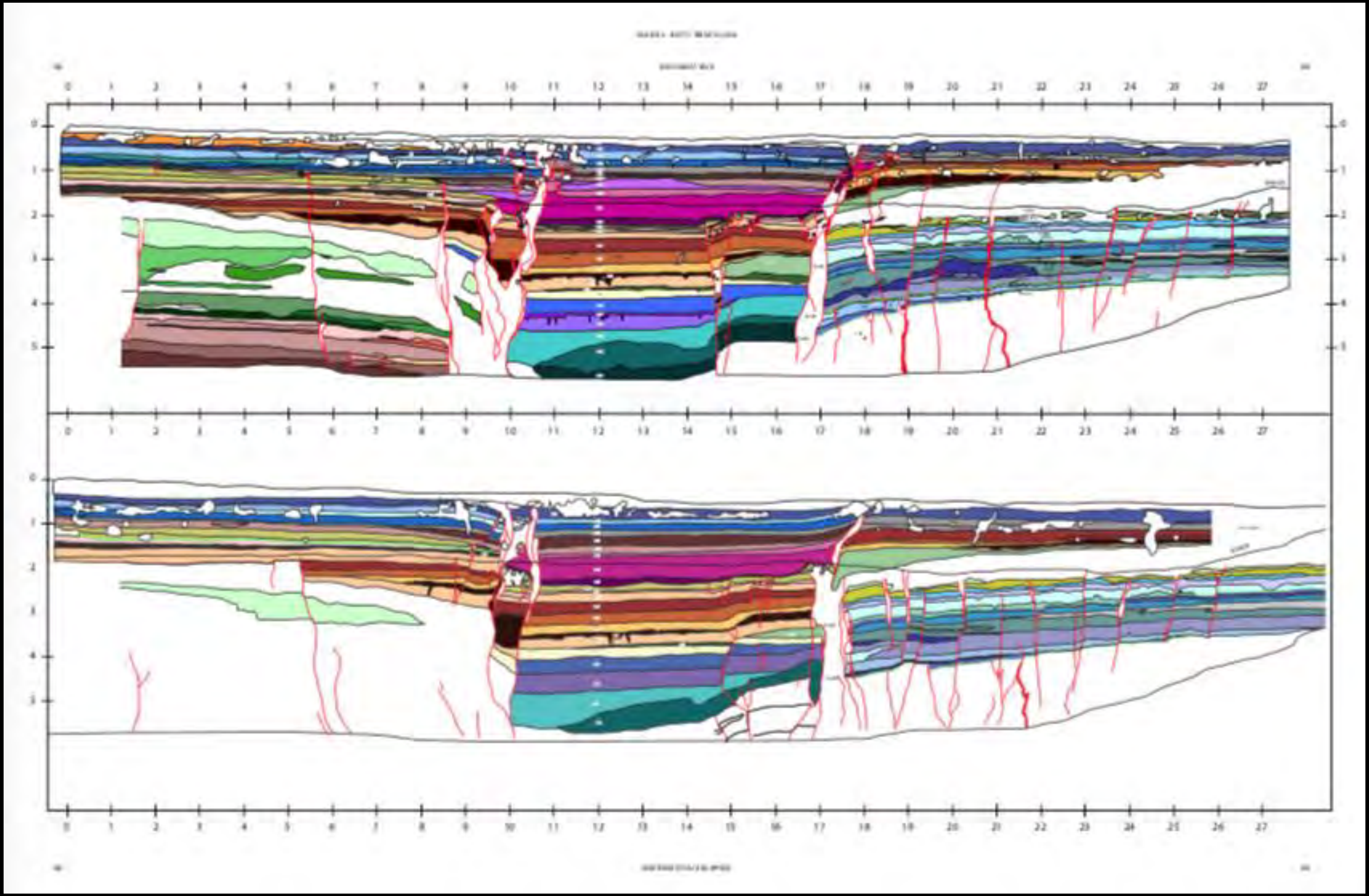
An alluvial fan that crosses the fault, which has cut through the fan and offset the sediments many times.

Rupture History of the San Andreas Fault in the Carrizo Plain prior to 1300 A.D.
Lisa Grant, Sinan O. Akciz



Bidart Fan


NW channel
T13
T3
T4
T9
T10
T5
T7
T8
T11
T12
T2
SE channel
0
20
50
100
Meters

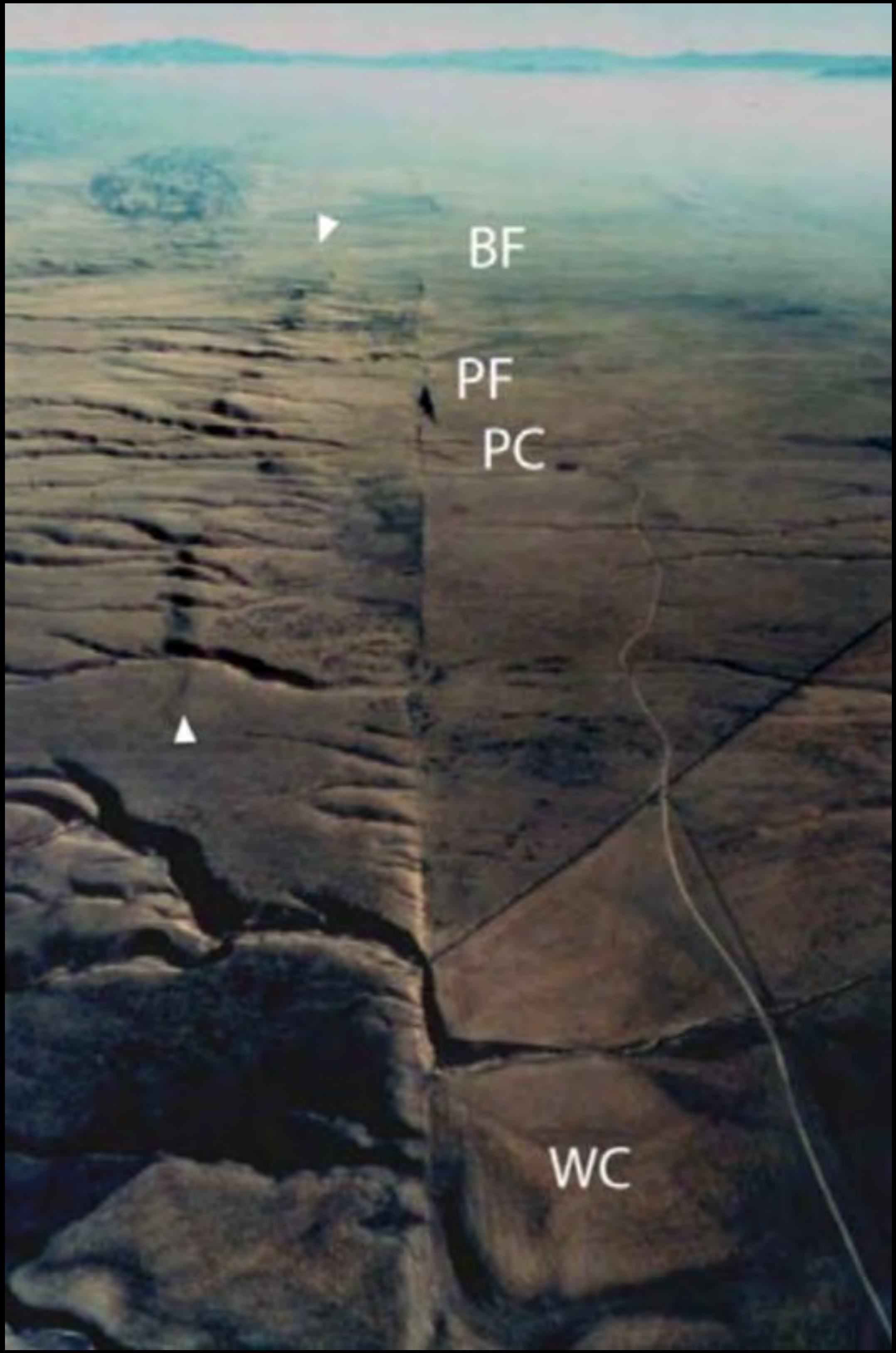


BIDART FAN SHOWS 6 RUPTURES FROM 1345 TO 1857.
OLDER QUAKES 666 - 430 BC, 817- 636 BC and 2,353 - 990 BC

The Bidart Fault

Paleoseismic investigation of an active fault scarp subparallel to the main trace of the San Andreas Fault at the Bidart Fan Site in the Carrizo Plain: Lisa Grant Ludwig, Sinan O. Akciz

Evidence for at least five, and possibly six, surface rupturing earthquakes. Preliminary results of analysis of 18 detrital charcoal samples indicate that these five earthquakes occurred since ~2,900 B.C. The two youngest ruptures occurred within the last 1650 years (since ~360 A.D.) Compared to the paleoseismic record at the Bidart Fan site, which is approximately 400 m to the SW, almost all of the Bidart Fault earthquakes (with the exception of MRE) are much older.

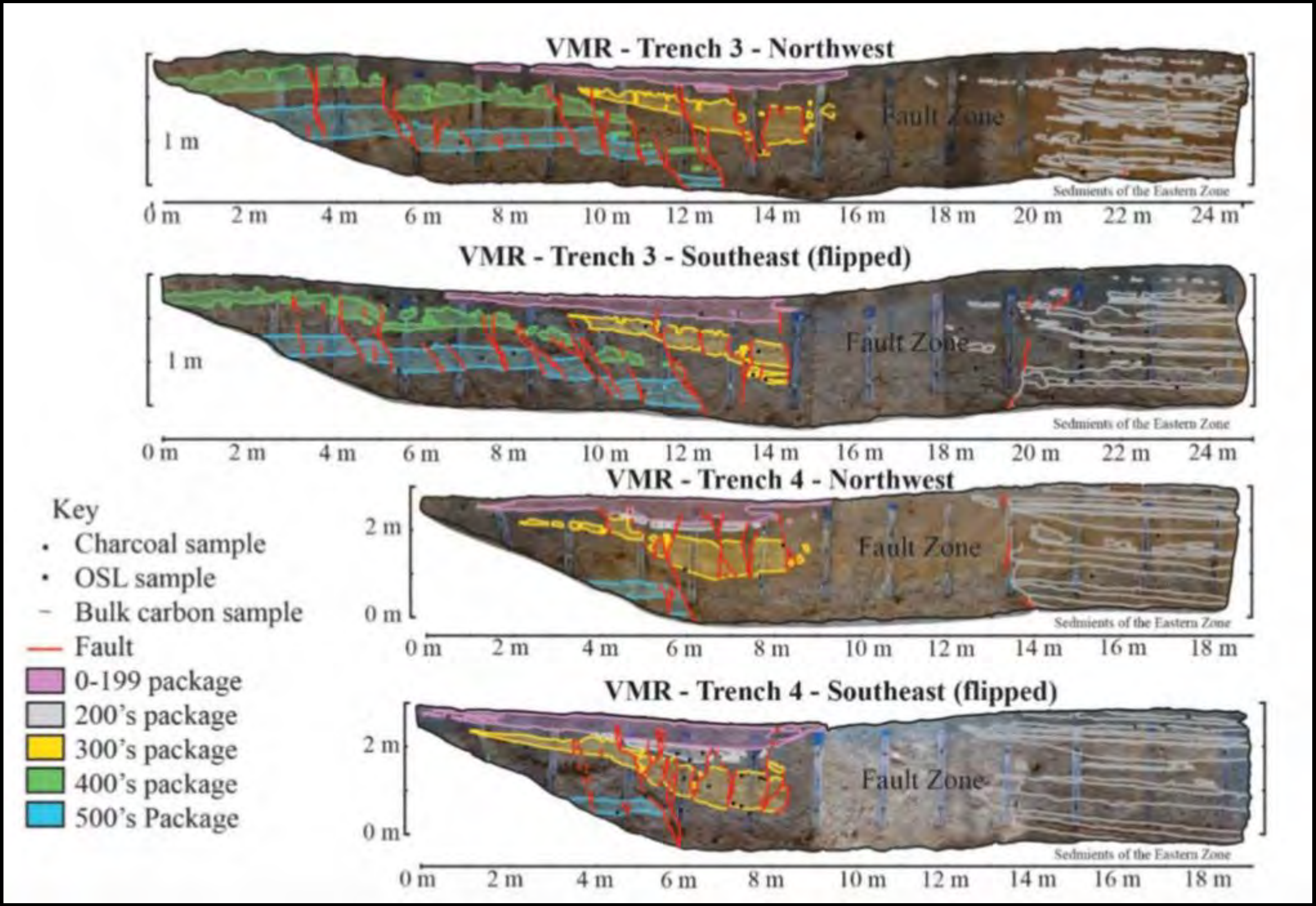


Van Matre Fan

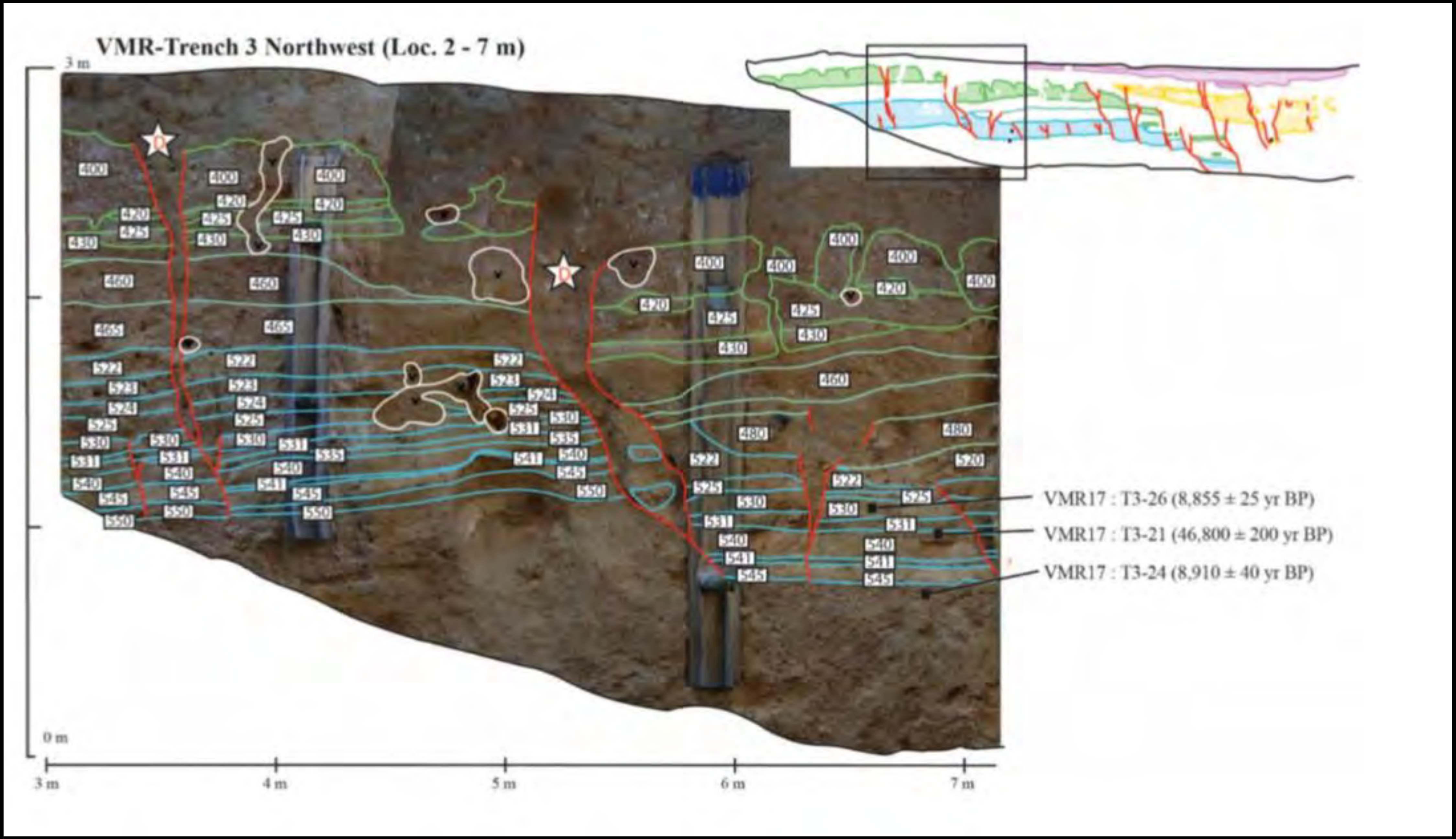
After Bidart Fan work ended, siimilar work started on the Van Matre Ranch, about 20 km SE of Bidart; (N35°8’45.60”, W119°41’16.92”)

2020 USGS NEHRP FINAL TECHNICAL REPORT
Paleoseismic Investigation of the Van Matre Ranch Site, Carrizo Plain, CA. Researcher Sinan O. Akciz

Event A (1857 A.D.), Event B (1681 – 1796 A.D.), Event C (1223 – 1447 A.D.), and Event D and E (both occurring between 7570 – 713 B.C.)



Example of cohesive sequences of strata in the trench wall (packages), with disturbed zones of uncertain age between them.



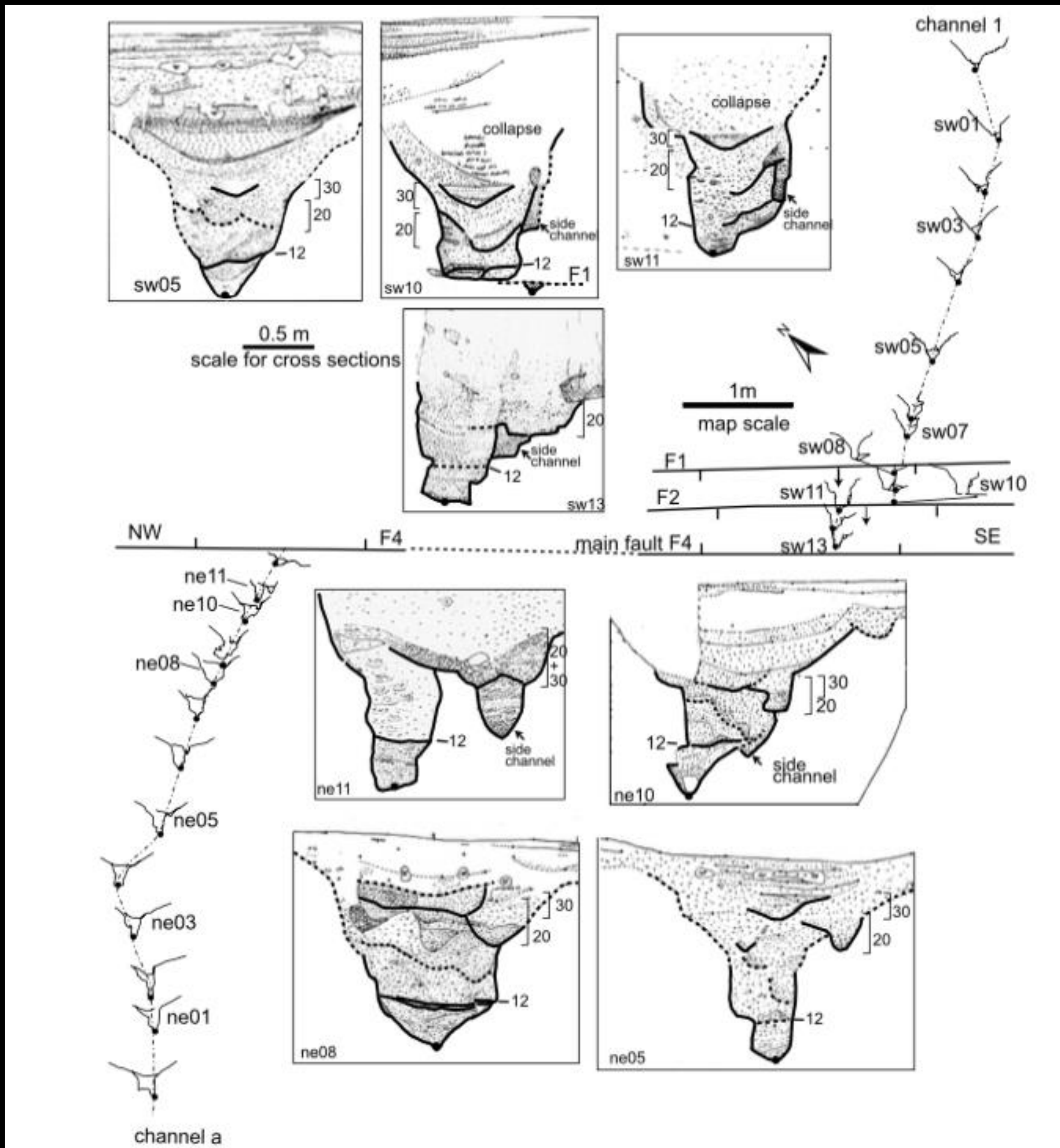
Example of figure of part of a trench wall showing charcoal collection and other samples used in age determination

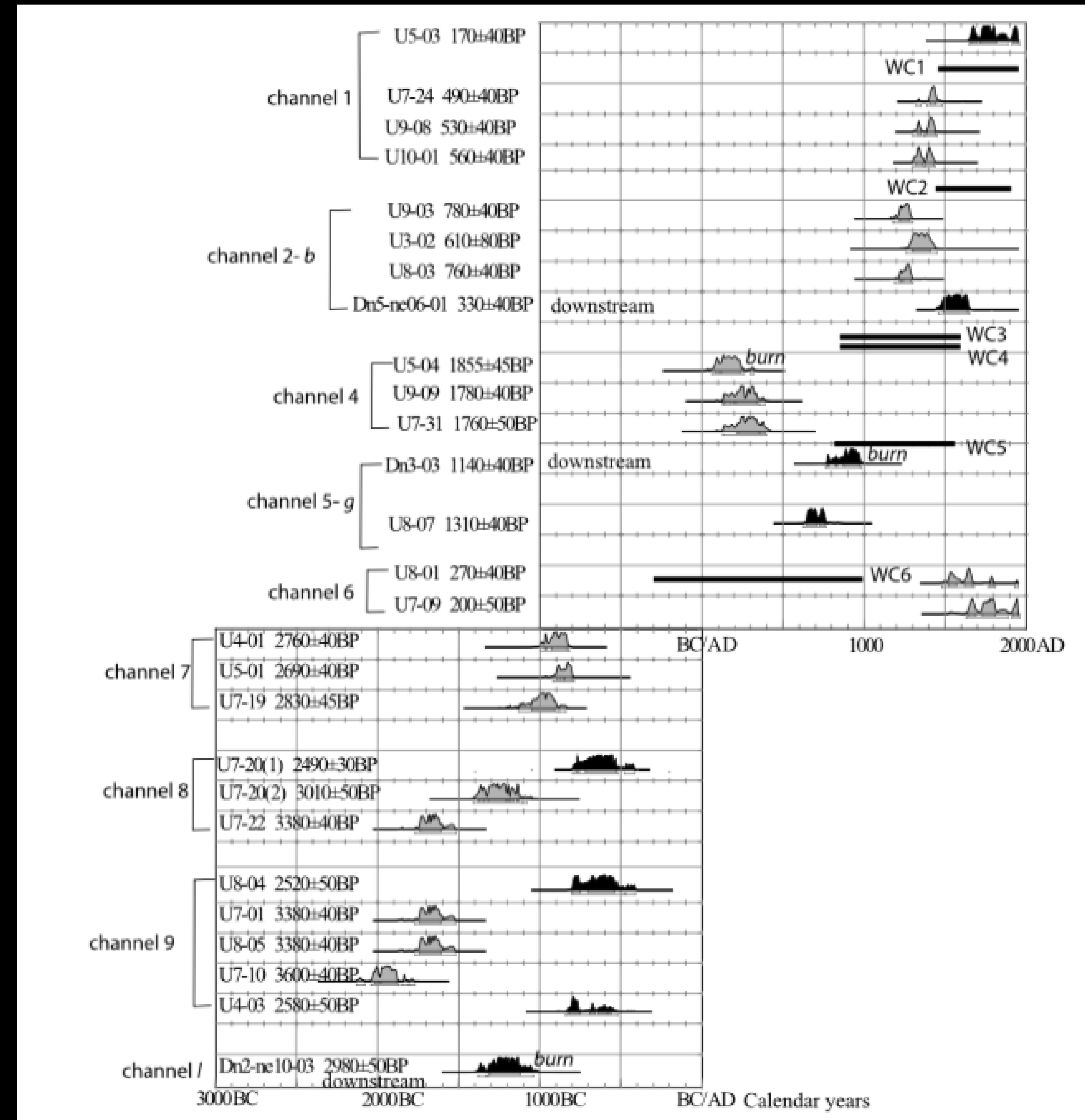
Seismic History

Details from the trace of the
San Andreas Fault
(b) Trenching parallel to the fault and channel
sediment-fill matching

es of the San Andreas fault, Carrizo Plain, California, revealed by three-dimensional excava
Jing Liu-Zeng, Yann Klinger, Kerry Sieh, Charles Rubin, and Gordon Seitz

(b) Trenching parallel to the fault



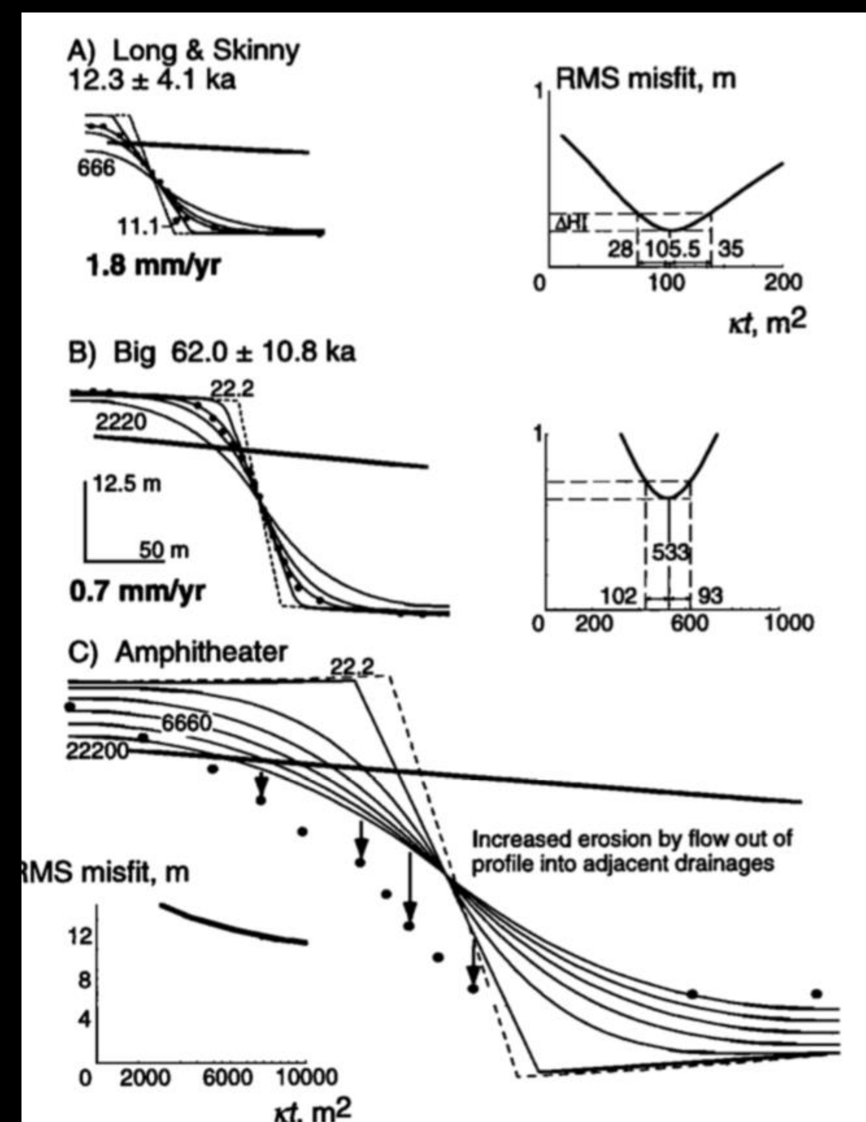


We find that the dextral slips associated with the six events in the last millennium are, from oldest to youngest, □ 5.4 ± 0.6, 8.0 ± 0.5, 1.4 ± 0.5, 5.2 ± 0.6, 7.6 ± 0.4 and 7.9 ± 0.1 m. In this series, three and possibly four of the six offset values are between 7 and 8 m. The common occurrence of 7–8 m offsets suggests remarkably regular, but not strictly uniform, slip behavior.

Fault Scarp Degradation

Morphologic dating of scarps formed by repeated slip
events along the San Andreas Fault, Carrizo Plain, California
J.R, Arrowsmith, Dallas D. Rhodes, David D. Pollard
The Geological Society of America. .GEOLOGY, v8. 36; no. 5; p. 367–370

One fault scarp began to form about 12kyr ago and the other about 63ky. Given the distance, this gives a slip rate of 1-2 mm.yr

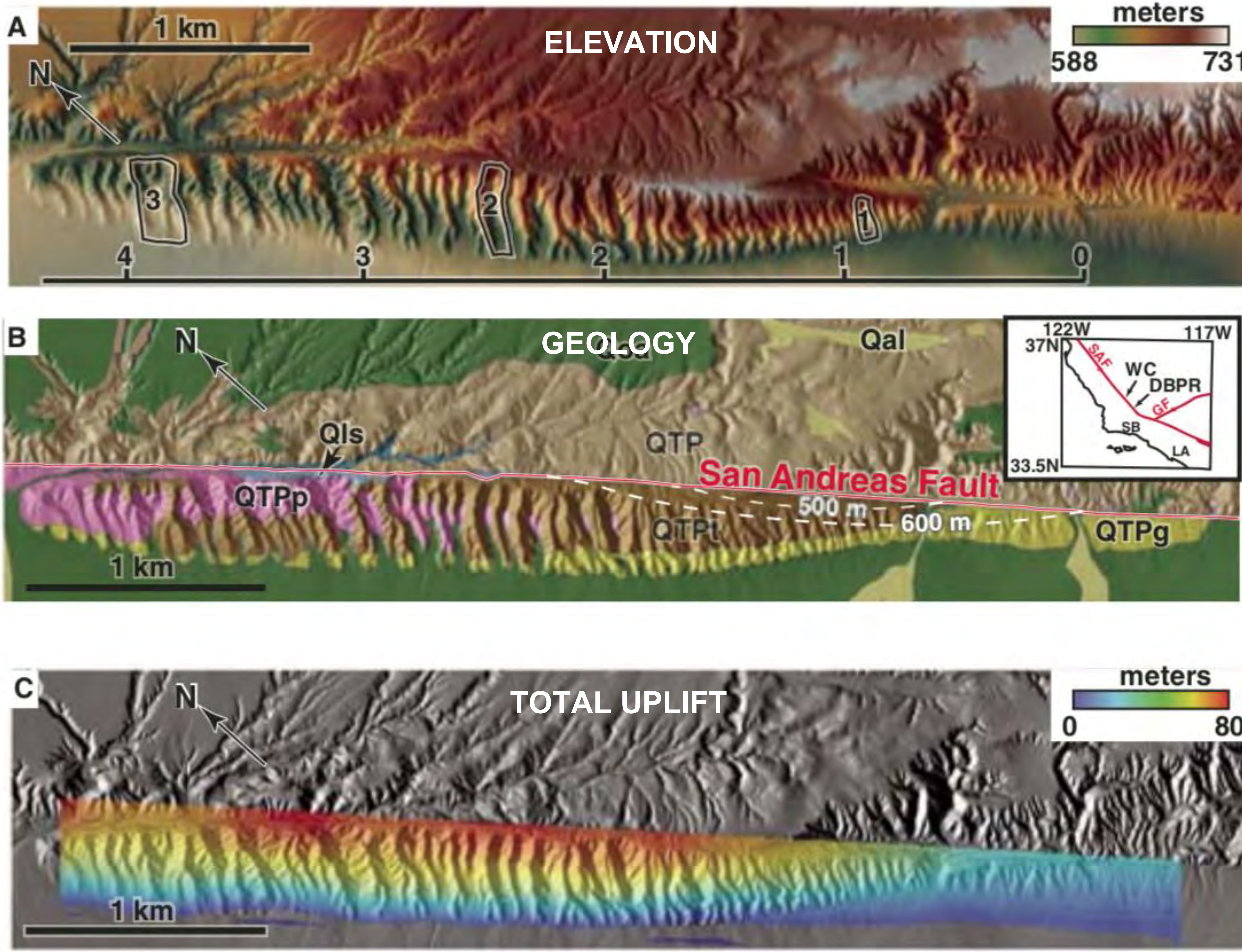


Dragon’s Back

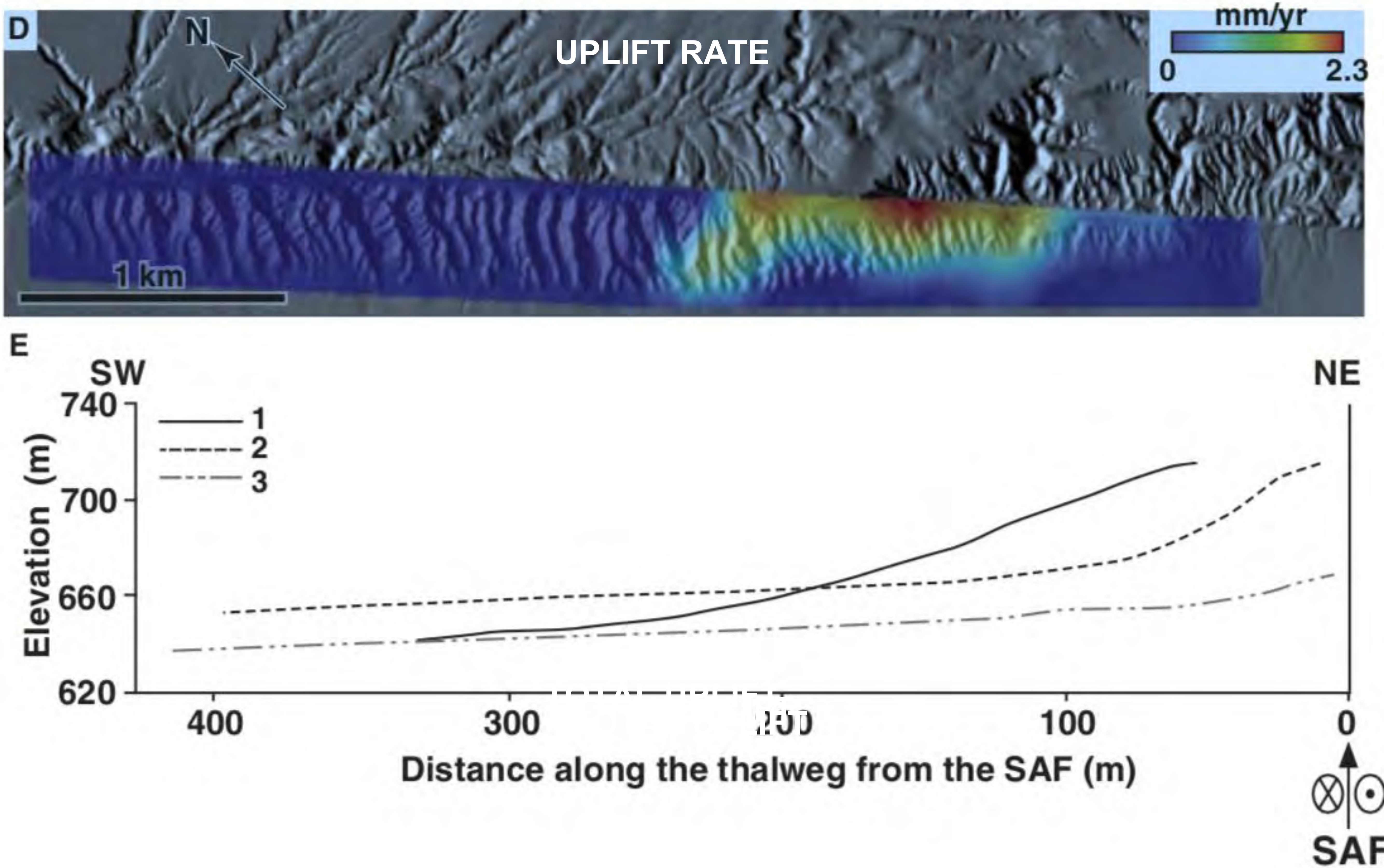
Geomorphic response to uplift along the Dragon’s Back pressure ridge, Carrizo Plain, California

George E. Hilley* Department of Geological and Environmental Sciences, Stanford University, Stanford, California 94305, USA J Ramón Arrowsmith School of Earth and Space Exploration, Arizona State University, Tempe, Arizona 85287, USA

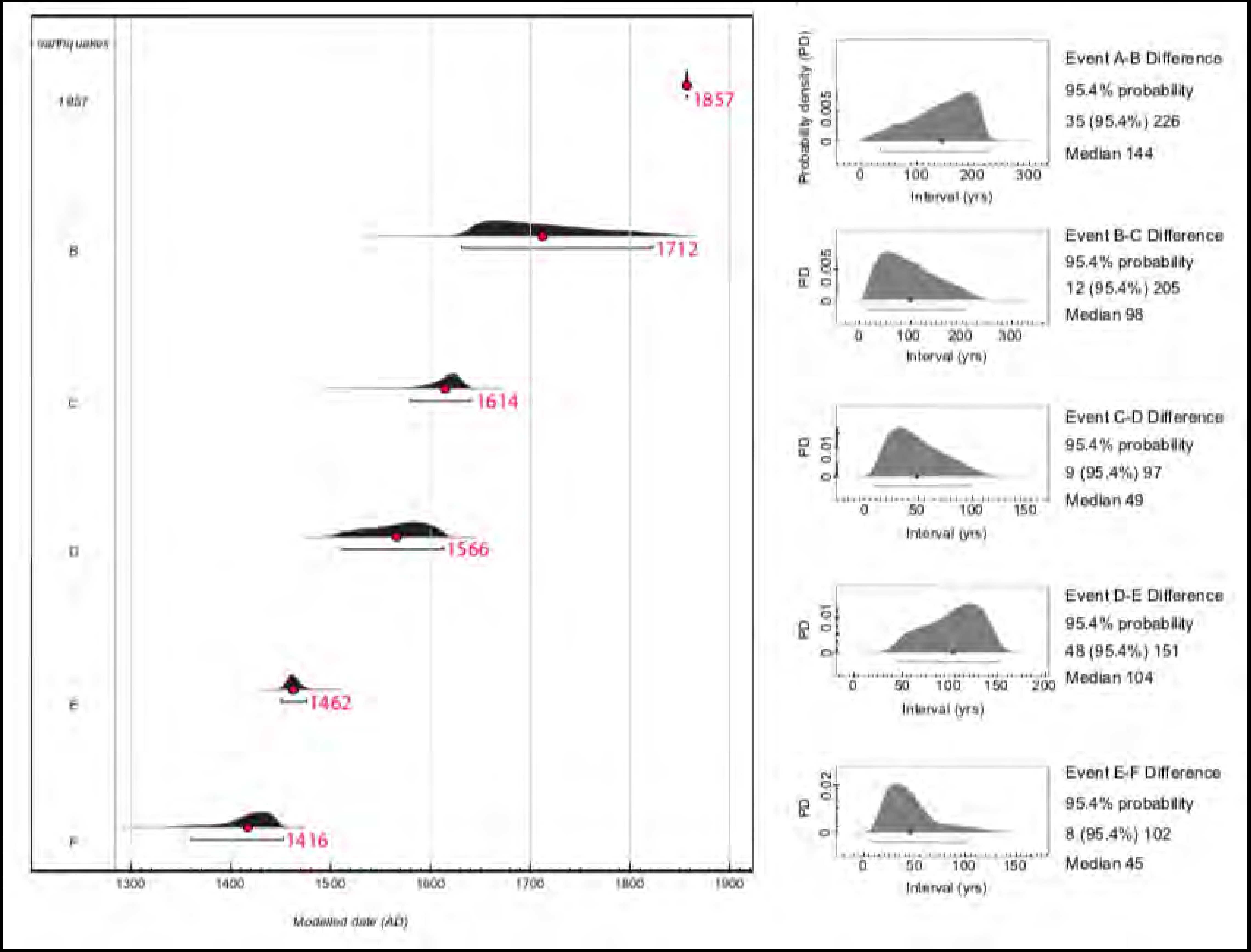
The Geological Society of America. .GEOLOGY, v8. 36; no. 5; p. 367–370



A
1 km
ELEVATION
meters
588
731
N
3
2
1
4
3
2
1
0
B
GEOLOGY
N
Qal
Qls
QTP
San Andreas Fault
QTPp
500 m
600 m
QTPt
QTPg
1 km
122W
117W
37N
SAF
WC
DBPR
GF
SB
LA
33.5N
C
TOTAL UPLIFT
N
meters
0
80
1 km


D
N
UPLIFT RATE
mm/yr
0
2.3
1 km
E
SW
NE
740
700
660
620
Elevation (m)
1
2
3
400
300
200
100
0
Distance along the thalweg from the SAF (m)
SAF

Offset Summary



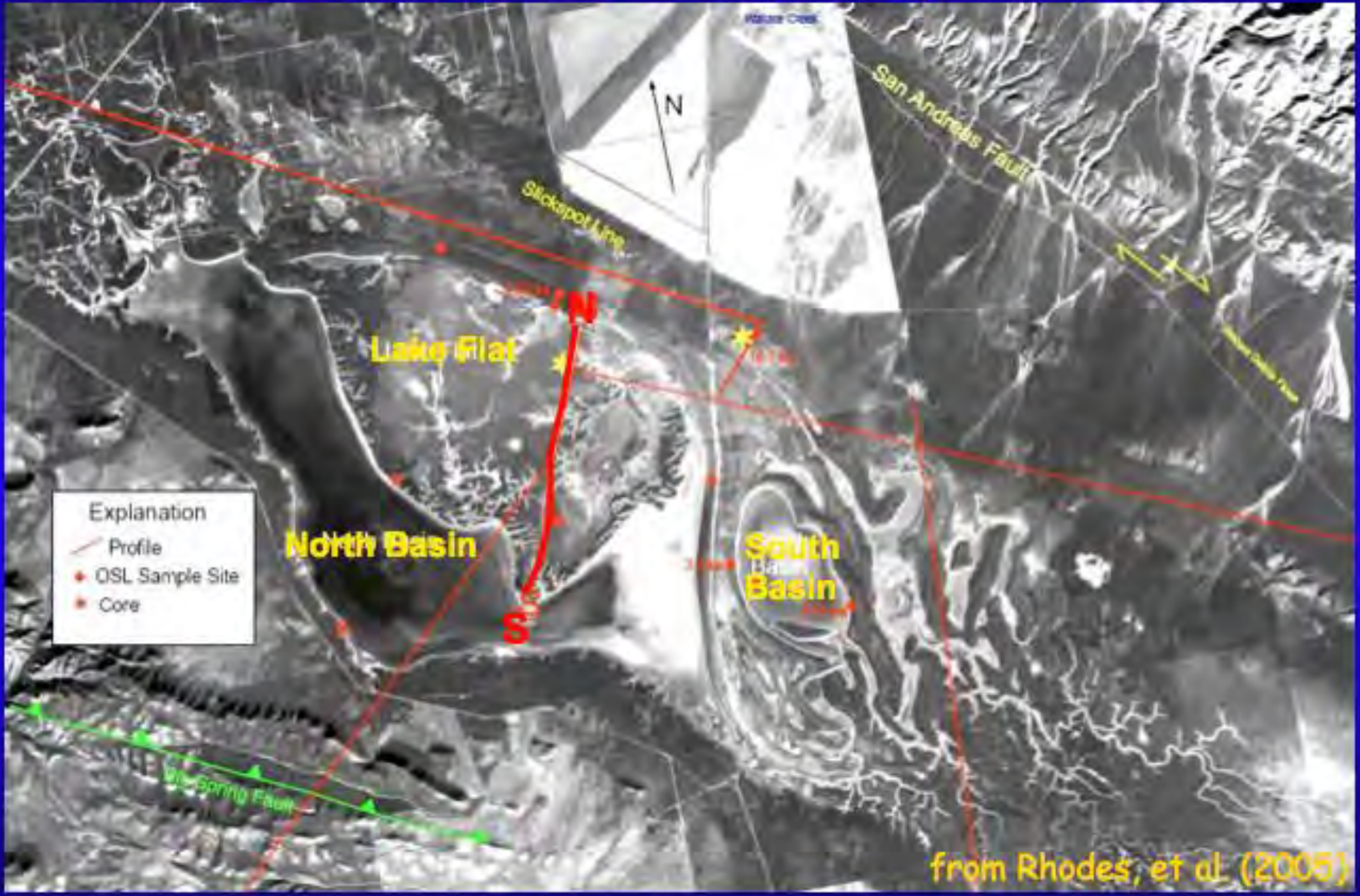
Part 2: Soda Lake

has its ups and downs

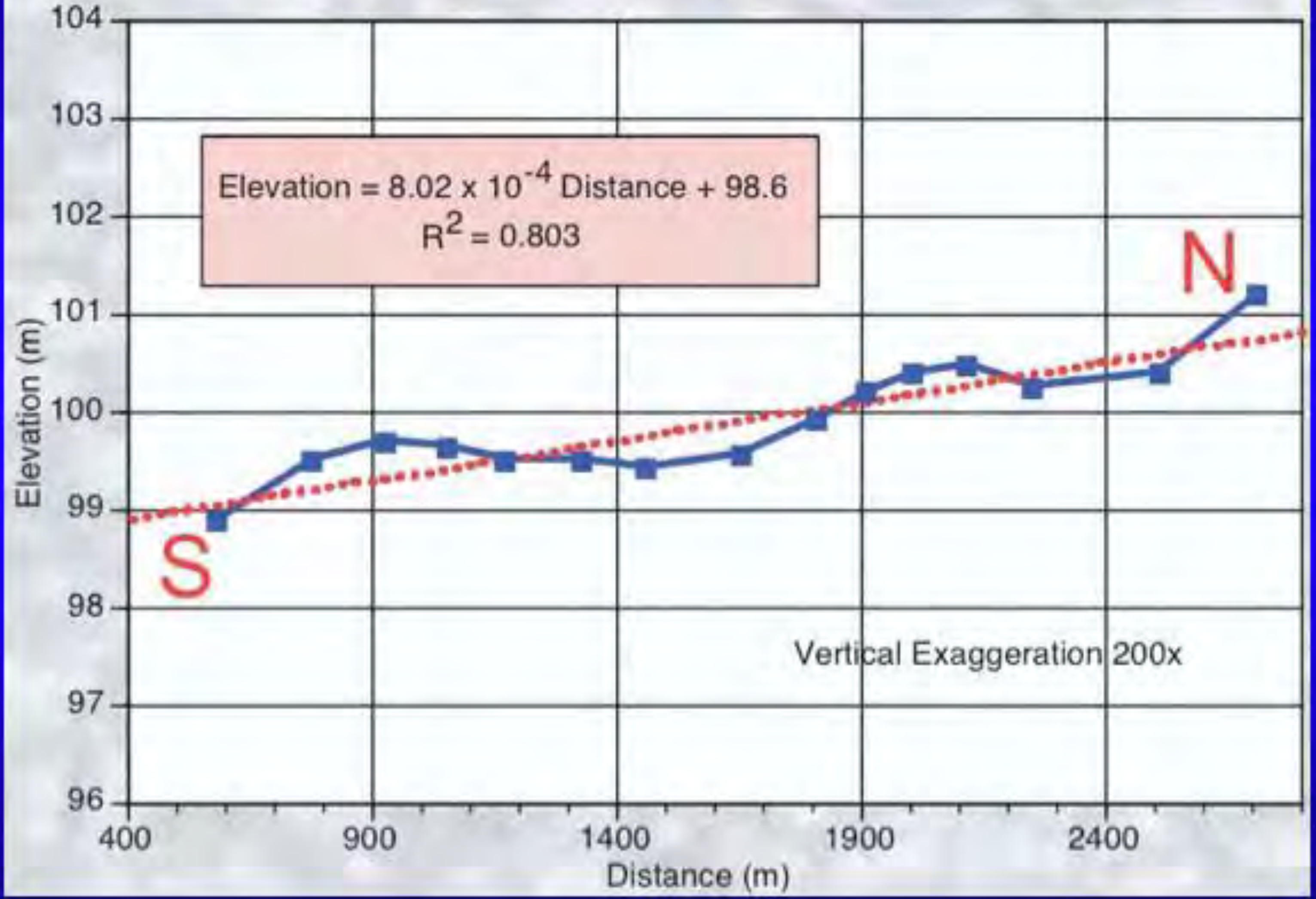
(1) Westward Tilting

CSU Bakersfield: R Negini, R. Stephenson, D. Baron, P Wigand
Georgia Southern Univ. : D. Rhodes, F. Rich
U.C. Irvine: L. Grant, G.Noriega

Location of Survey Line



Tectonic Tilting of Lake Basin



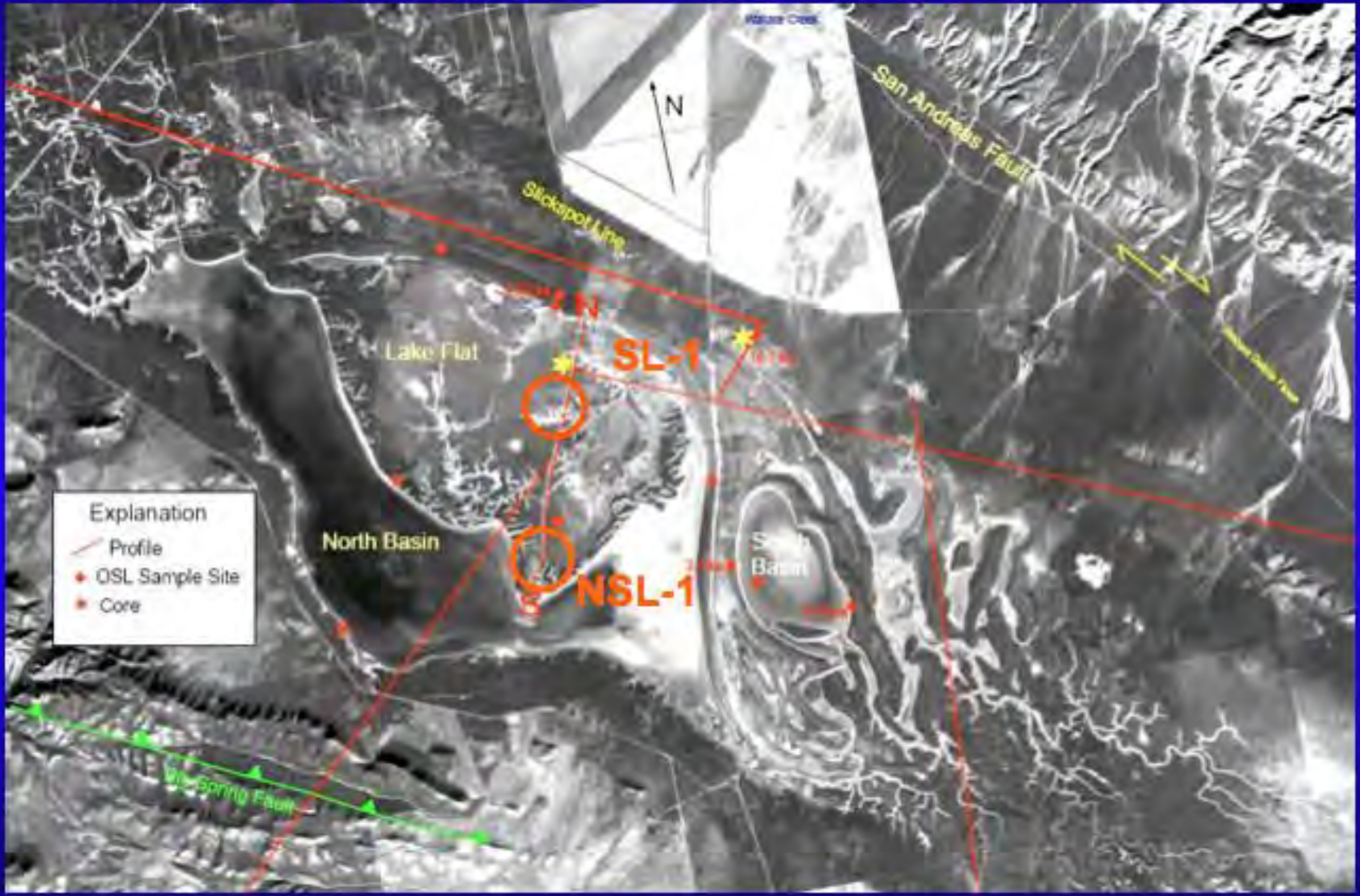
Soda Lake

has its ups and downs

(2) Sediment Record and Lake Level

Geological Society if America Special Paper 516
SCSU Bakersfield: D. Rhodes, R Negini, J.R. Arrowsmith,
P. Wigand, S. Forman, M.R. Palacious-Fest, O. Davis

Carrizo Plains Coring Sites



Oxidized Lithology

- light olive-brown (5Y 6/4)
- 1-10 mm, euhedral, gypsum xtals common
- microscopic gypsum xtals in clay matrix
- relatively high magnetic susceptibility (κ=20-60 cgs units)
- massive
- pollen preservation very poor throughout core
- 10-20 μm charcoal ubiquitous
- no diatoms

Reduced Lithology

- *dark gray (5Y 4/1); greenish gray (10Y or 10GY 5/1)*
- *1-10 mm, euhedral, gypsum xtals UNcommon; sometimes in discrete layers*
- microscopic gypsum xtals in clay matrix
- *very low magnetic susceptibility (κ<20 cgs units)*
- massive
- pollen preservation very poor throughout core
- 10-20 µm charcoal ubiquitous
- no diatoms

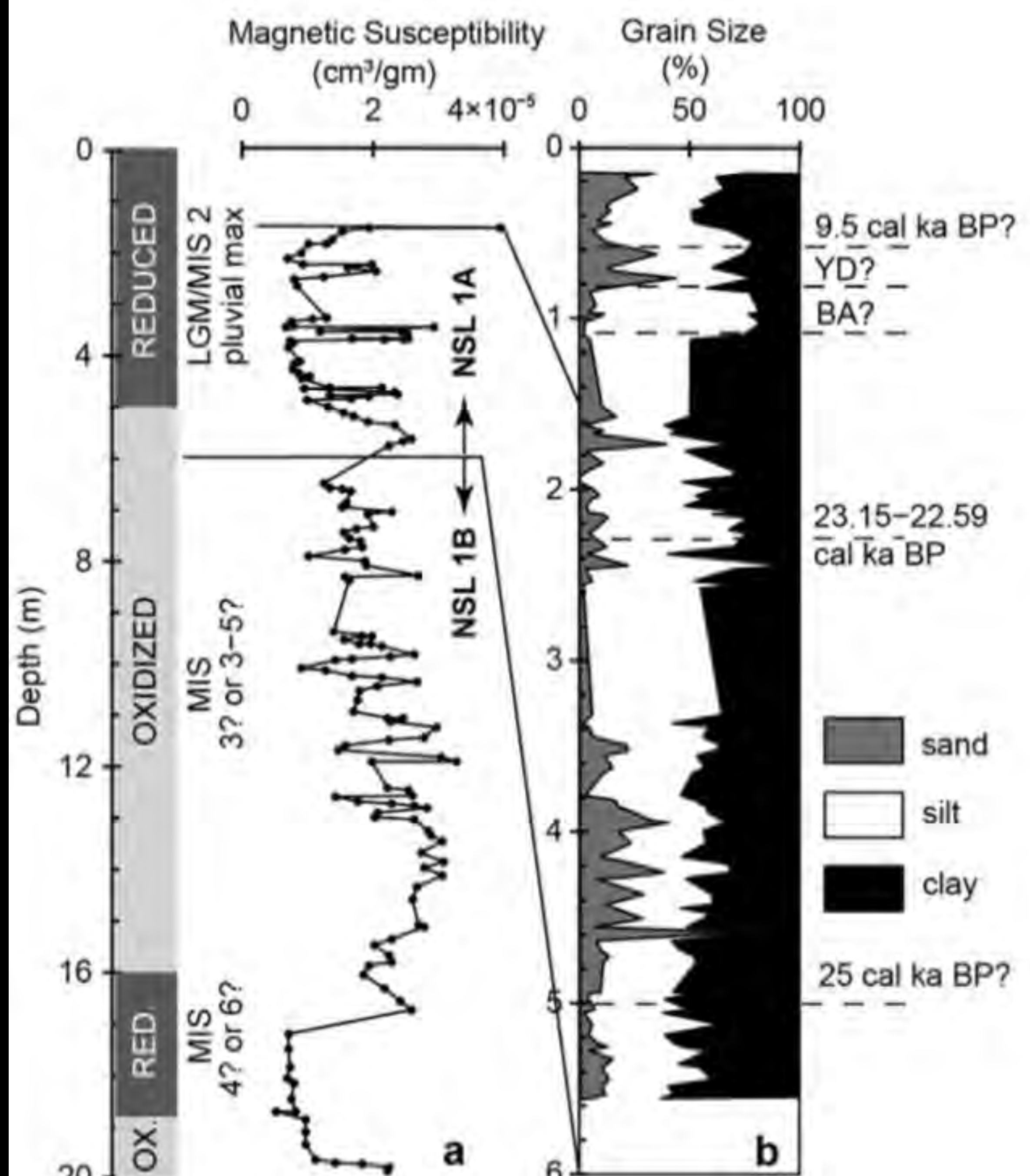


Figure 2. (**a**) Whole-core magnetic susceptibility [36,37] and (**b**) relative grain size distributions [44]. MIS = Marine Isotope Stage, LGM = Last Glacial Maximum.

Article

Geochemical Record of Late Quaternary Paleodepositional Environment from Lacustrine Sediments of Soda Lake, Carrizo Plain, California

Alejandro Rodriguez, Junhua Guo *, Katie O'Sullivan and William Krugh

Minerals **2024**, *14*, 211. https://doi.org/10.3390/min14030211

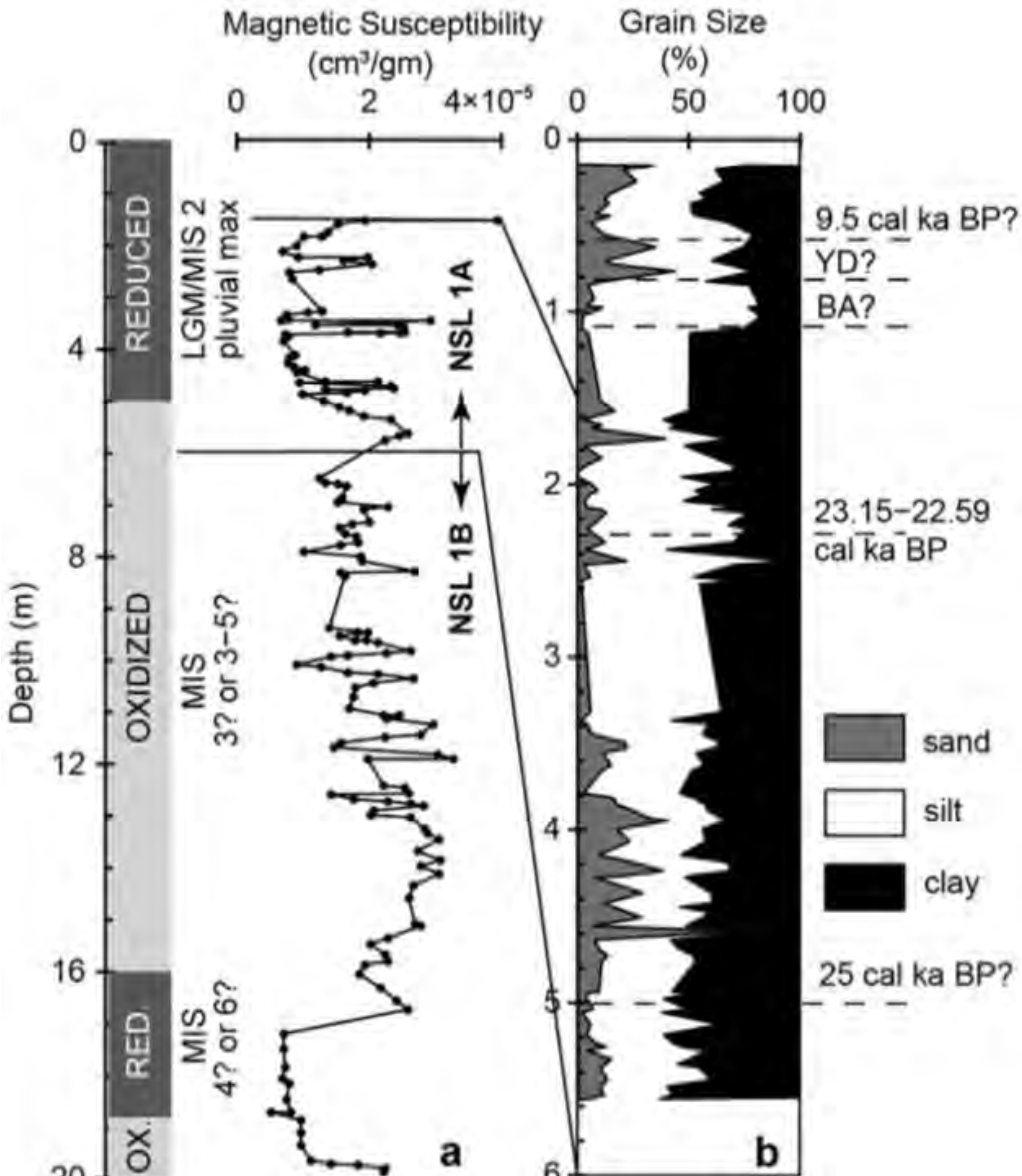
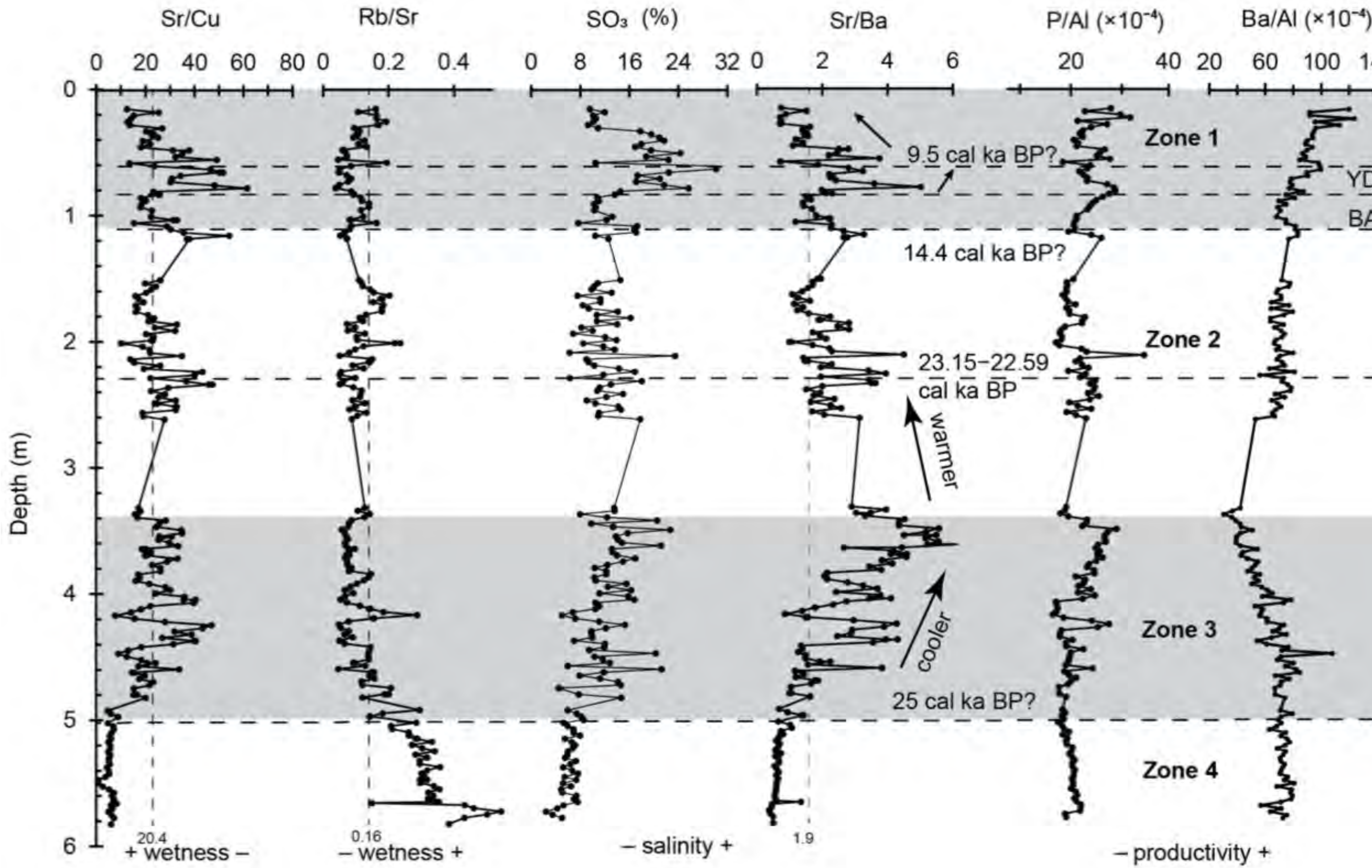


Figure 2. (**a**) Whole-core magnetic susceptibility [36,37] and (**b**) relative grain size distributions [44]. MIS = Marine Isotope Stage, LGM = Last Glacial Maximum.

Reduced oxidation implies deeper water and possible stratification of the water body. Sediment has fewer salt crystals and fewer ostracods compared to the oxidized zones



Trace element proxies that reflect environmental conditions such as wetness. salinity, and biological productivity

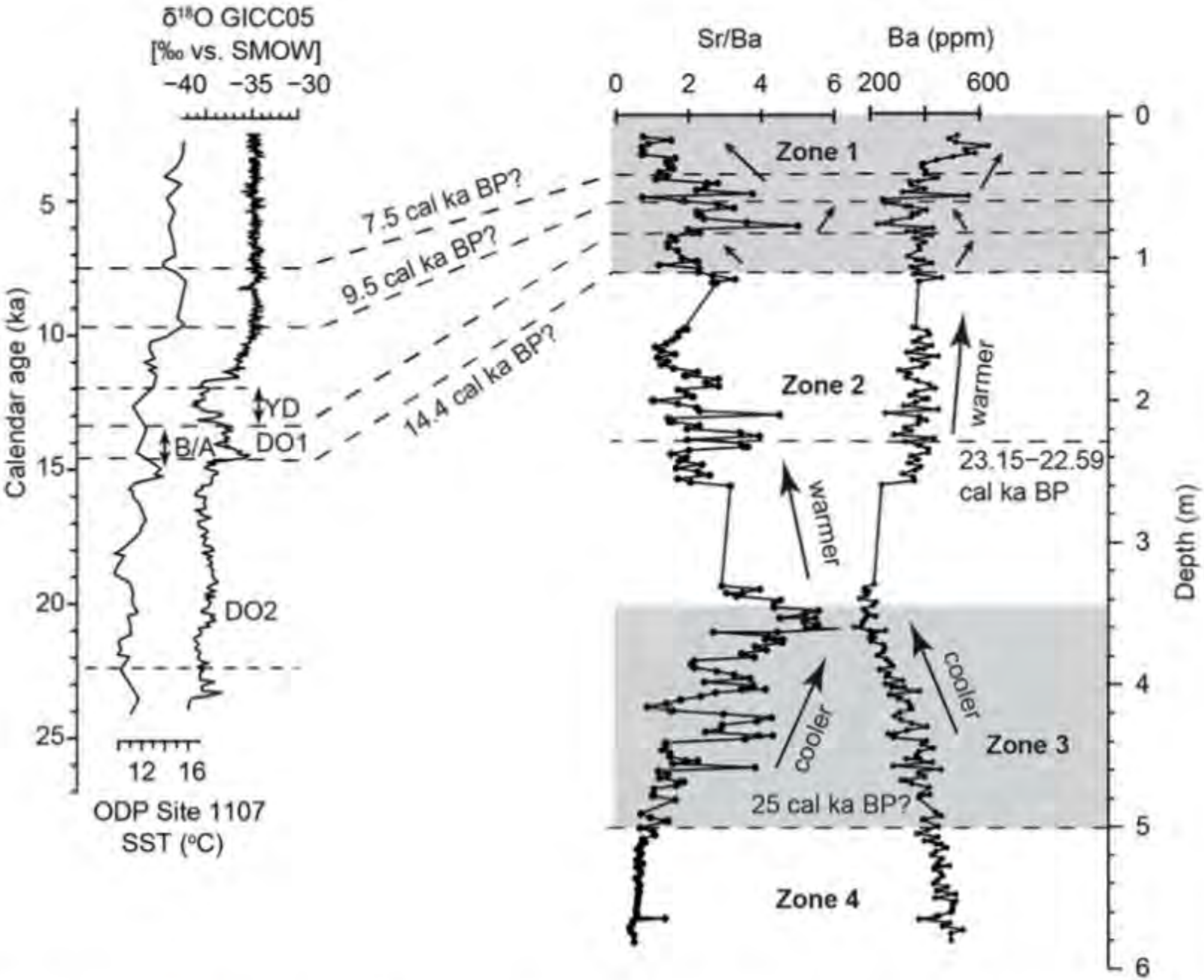
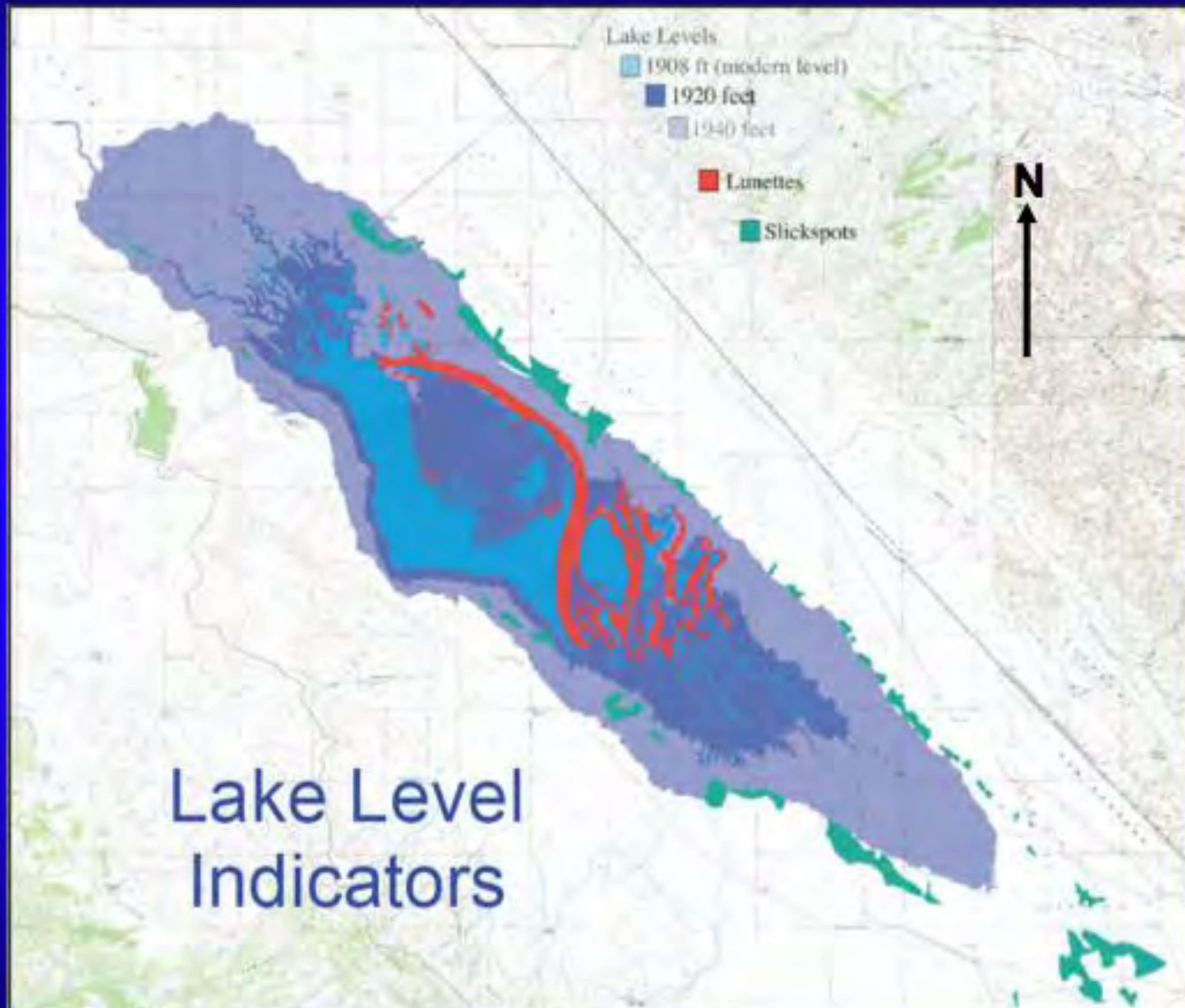
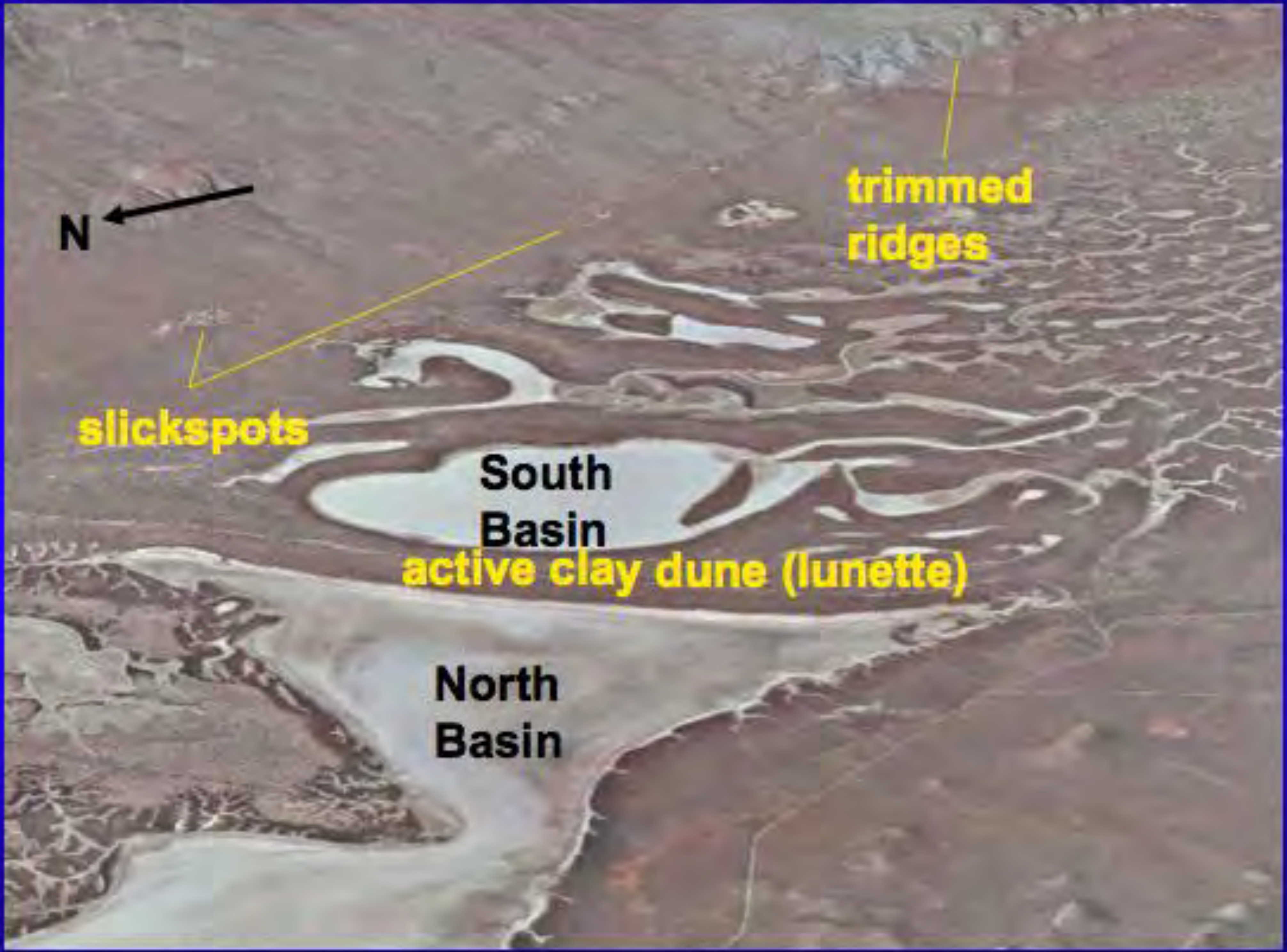


Figure 7. Comparison and correlation of proxies Ba and Sr/Ba to the variations in Pacific sea surface temperature [106] and the ratio of stable isotopes oxygen-18 and oxygen-16 ($\delta^{18}O$) in the Greenland

Lake Level Indicators

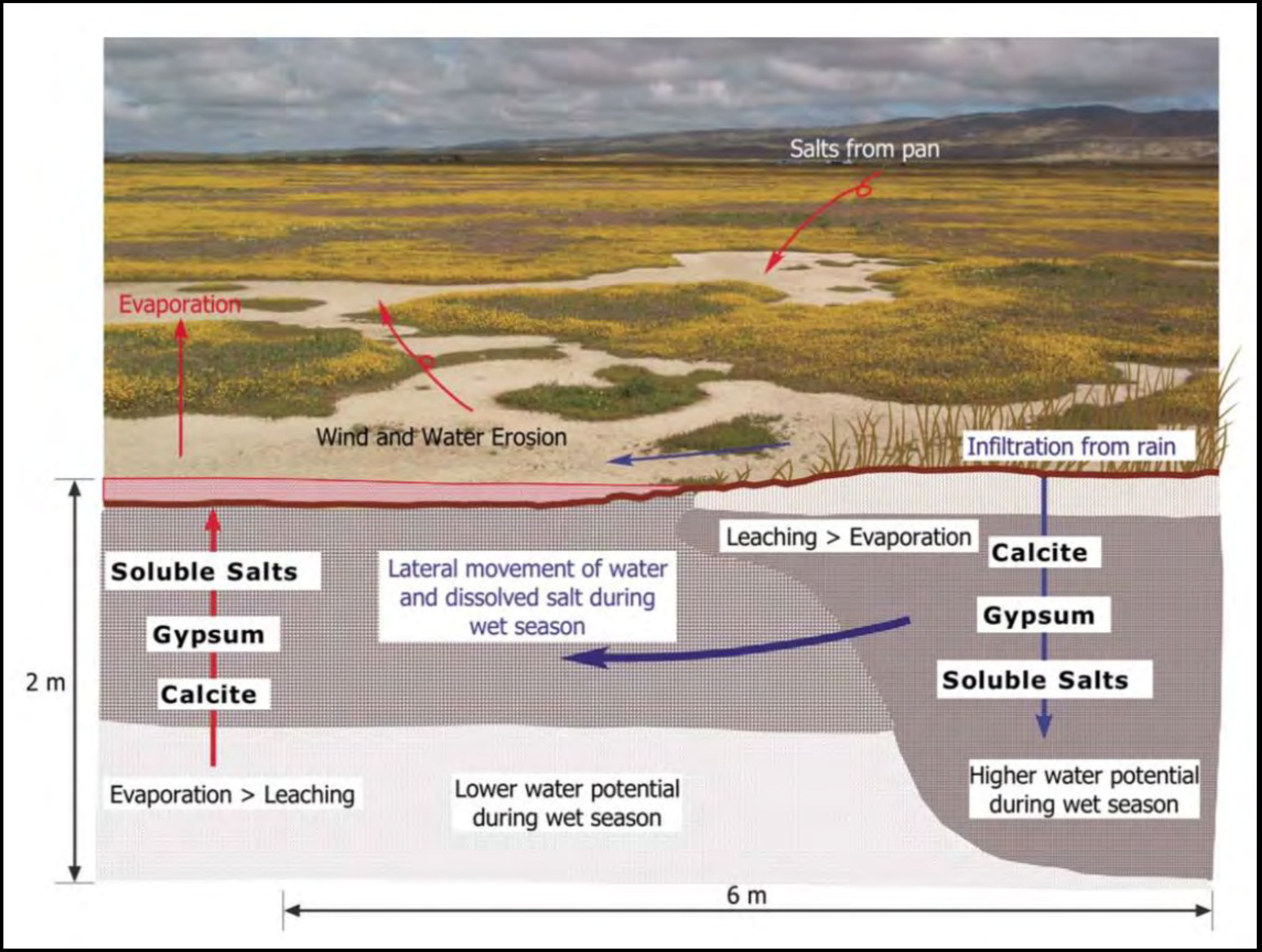



trimmed
ridges
N
slickspots
South
Basin
active clay dune (lunette)
North
Basin

Geological Society if America Special Paper 516

SLICKSPOTS

When the concentration of sodium reaches a threshold, clay-sized particles are evenly dispersed, eliminating pore spaces, and making the soils nearly impermeable (Chadwick and Chorover, 2001). The abundance of sodium in the clay cap also renders the spots unsuitable for the growth of most vegetation.



Geological Society if America Special Paper 516

SLICKSPOTS

NORTHEAST

SIDE OF LAKE

1,940 ft contour

SOUTH END

OF LAKE

1,968 ft contour

WEST SIDE OF

LAKE

1,919 ft contour

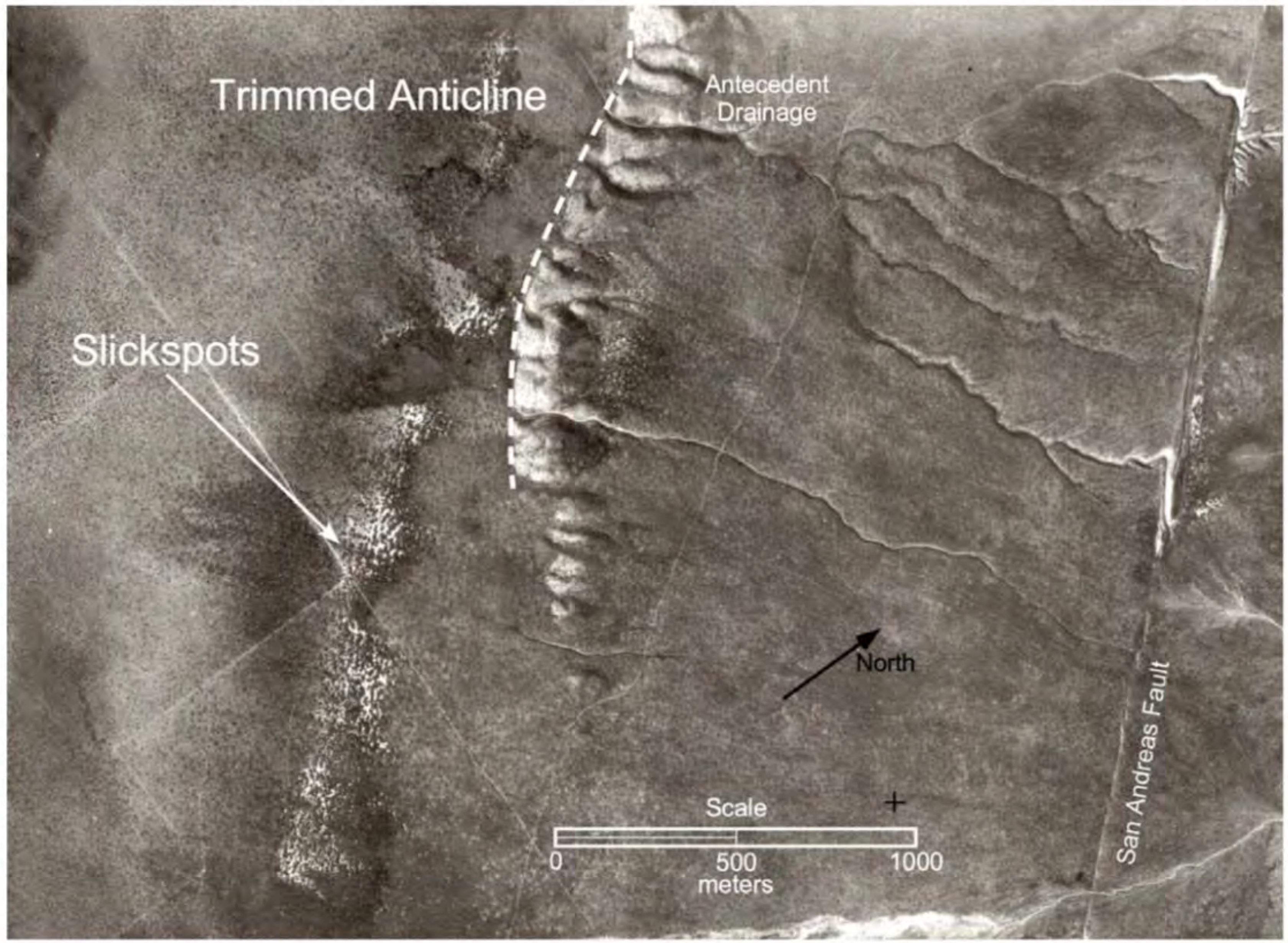


Figure 8. Aerial photograph showing slickspots, a trimmed anticline, and the San Andreas fault. See Figure 7 for the location of this site. The photo is from the Fairchild Aerial Surveys flight C-3883, frame 24, dated February 1936. The tip of the arrow pointing to the slickspot is located at approximately 35°11′25″ N, 119°46′28″ W.

SLICKSPOTS

WEST SIDE OF LAKE

1,919 ft contour

Slickspots and *Allenrolfia*

Allenrolfia occidentalis

This plant appears to require high salt conditions, but where fresher subsurface water moving toward the shore is forces upward by underlying, denser, saline waters and by the sealing of clay porosity casued by the salts. Hence it is a probably proxy for a shoreline habitat,

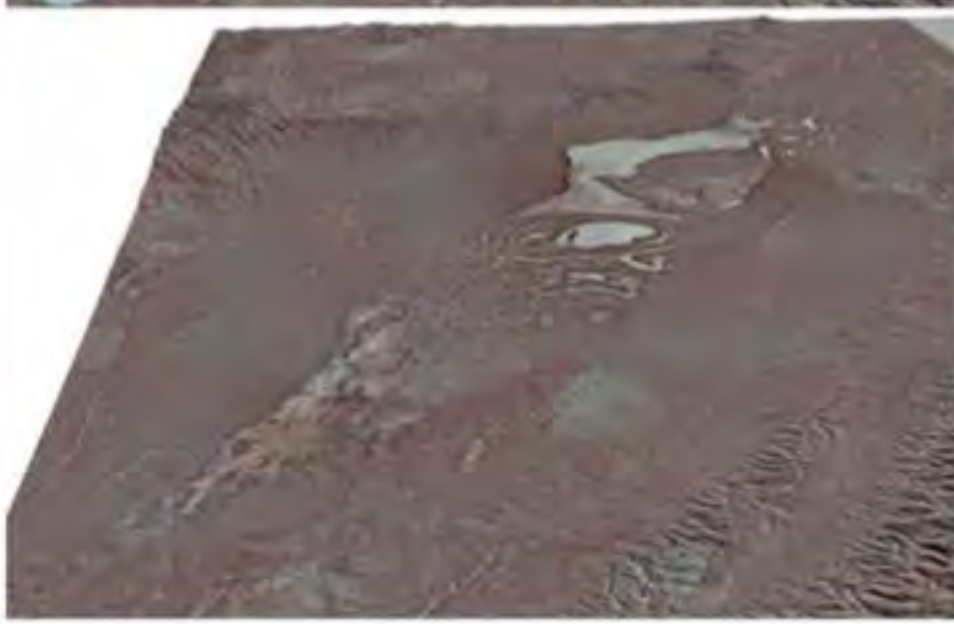
High Stand (~595 m) at ~16.7 ka

Evidence for lake level
1) Outermost dune ridge
2) Slickspot distribution
3) Straight basin-side edges anticlinal ridges

Timing
Minimum of 16.7 ka
(OSL date of Outermost dune)

Shrinkage
Climate change (?)
Pleistocene-Holocene

Geomorphic evidence for 17m variation in lake depth



Modern (~582 m)

Summary

- 40 m core acquired from Carrizo Plain
- End member lithologies deposited under reducing and oxidizing lake conditions
- Lithologies have characteristic magnetic susceptility signatures allowing for identification of lithologies at cm-scale spatial resolution throughout core
- Initial dating suggests that reduced lithology corresponds to high lake levels and that the 40 m core sampled sediments into MIS 7
- Hypothesis may be testable by analysis of ostracodes recently collected in reduced zone
- Potential record for high resolution correlation to Santa Barbara Basin records

Past Climate

Superfloods and Sag Ponds

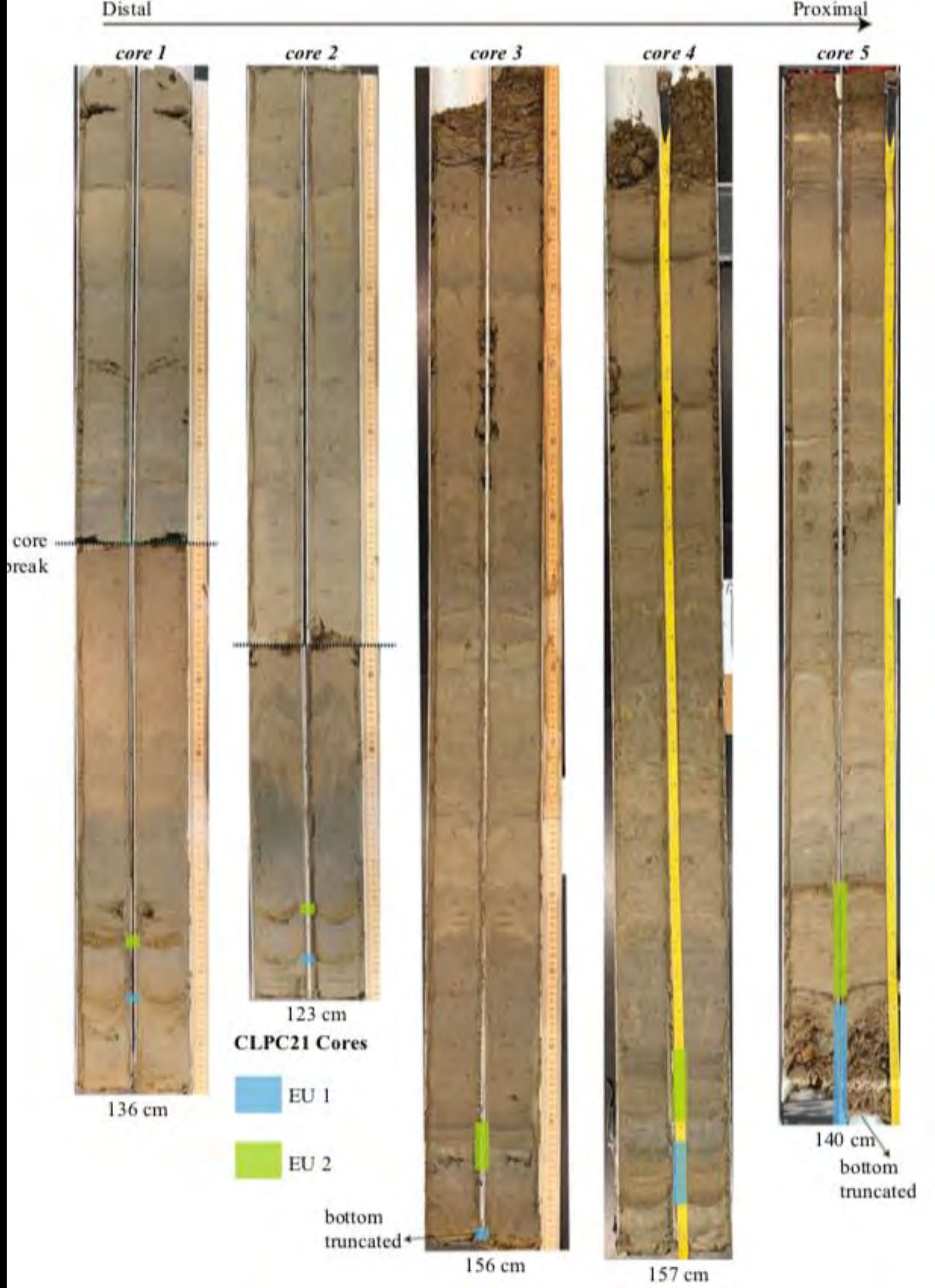
Little Ice Age flood events recorded in sag pond sediments in the Carrizo Plains National Monument, California ***2024 Paleolimnology***

Matthew Kirby · Samuel K. Hippard ·

Lisa N. Martinez · Dahlia Serrato · Joseph Carlin · Nicole Bonuso ·

Sinan O. Akçiz · Christian Novich


B)
C)
A)
fan-delta
major inlets
CLPC21-5
CLPC21-4
CLPC21-3
CLPC21-1 & 2
W119.48°
primary runoff area
5
4
3
1
2
400 m
Google Earth
NV
CA
AL
CPSP
ZL
ML
SG
SBB
LE
core site
N
80 m



Distal
Proximal
core 1
core 2
core 3
core 4
core 5
core
break
136 cm
123 cm
CLPC21 Cores
EU 1
EU 2
bottom
truncated
156 cm
157 cm
140 cm
bottom
truncated

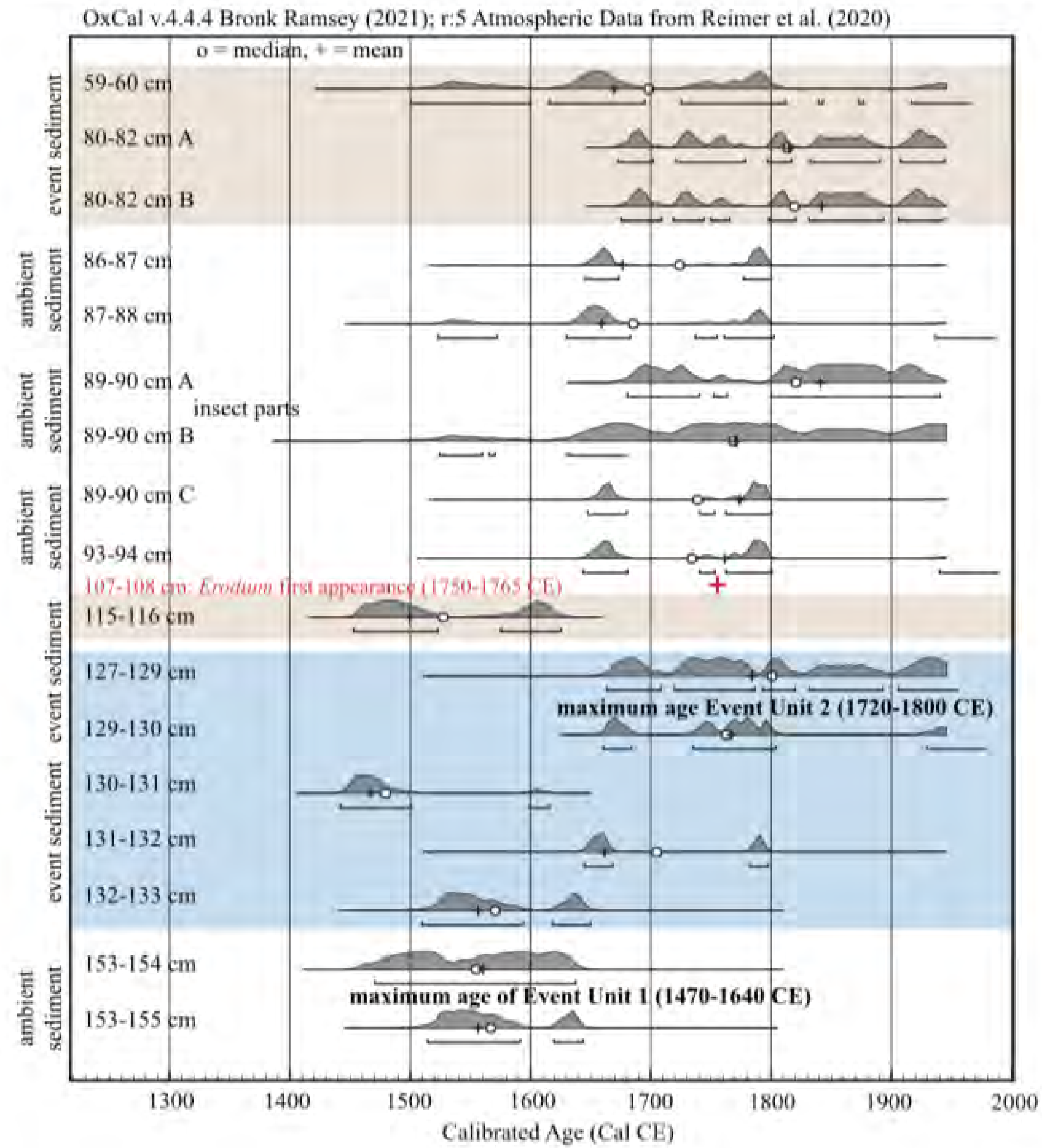


Fig. 6 All ^{14}C ages calibrated to years CE using OxCal (v.4.4.4) with the 95.4% confidence range (black **o** = median, black + = mean). First appearance of *Erodium* is shown with a red + and its approximate age range (Mensing et al. 1998). Ambient versus event sedimentation as determined by PC1 values are shown along the left y-axis. Proposed maximum age of EU 1 and EU 2 are shown bolded text at the 95.4% confidence range

Two units (EU 1 and EU 2) are especially distinct within CLPC21-4, characterized by erosive bases, above average sand content, normal grading, low magnetic susceptibility, and low total organic matter. Moreover, they are visually apparent across all five cores within the sag pond and thin from source to sink.