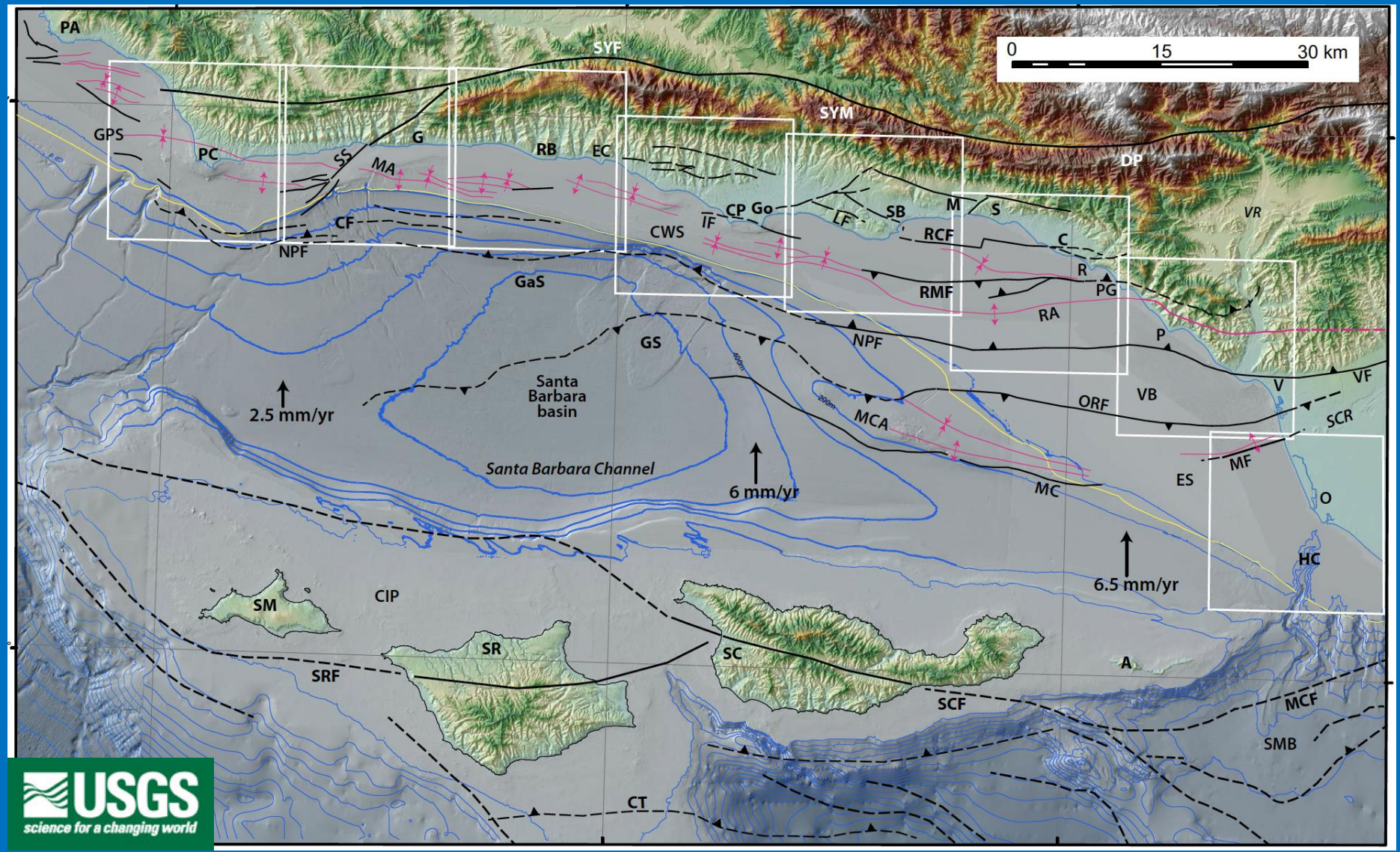


Marine geomorphic and seismic-reflection evidence for latest Pleistocene to Holocene tectonic activity, northern Santa Barbara Channel

Sam Johnson (USGS Emeritus) – SCEC Workshop, June, 2025

Contents lists available at ScienceDirect

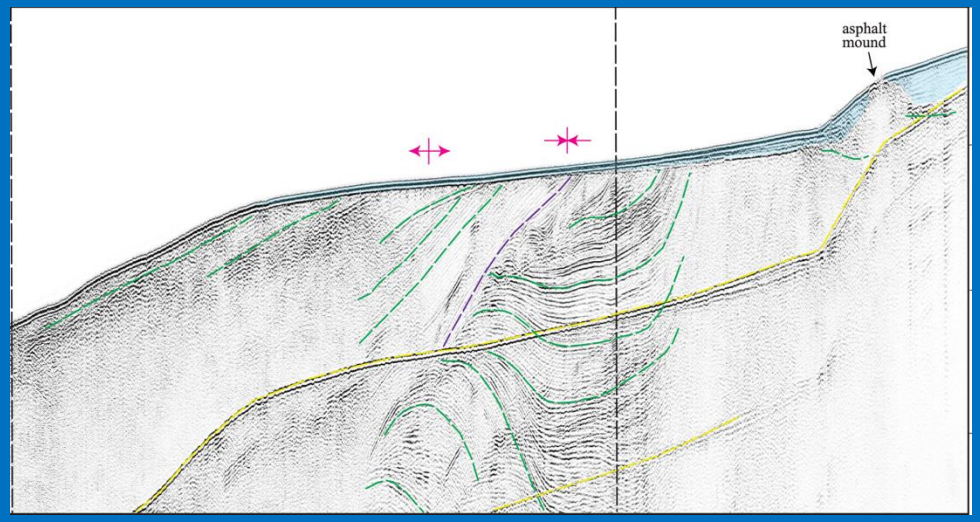
Ocean & Coastal Management

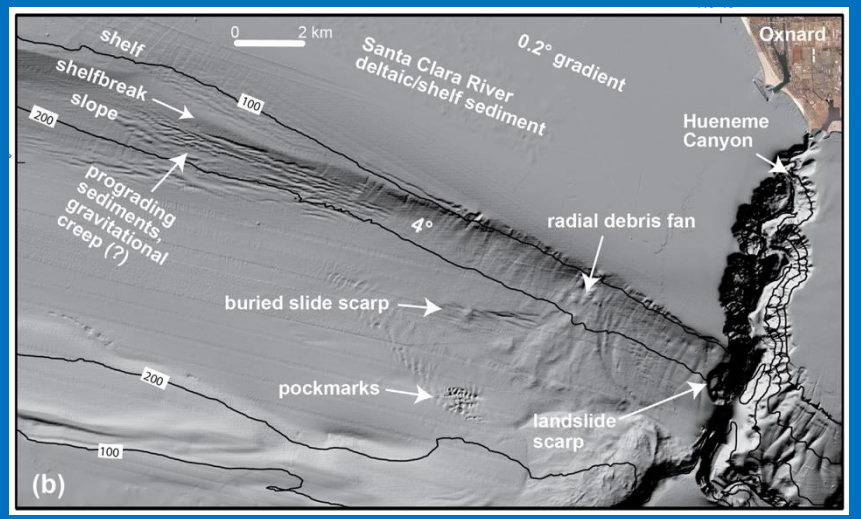
journal homepage: www.elsevier.com/locate/ocecoaman

The California Seafloor and Coastal Mapping Program – Providing science and geospatial data for California's State Waters

Samuel Y. Johnson*, Guy R. Cochrane, Nadine E. Golden, Peter Dartnell, Stephen R. Hartwell, Susan A. Cochran, Janet T. Watt

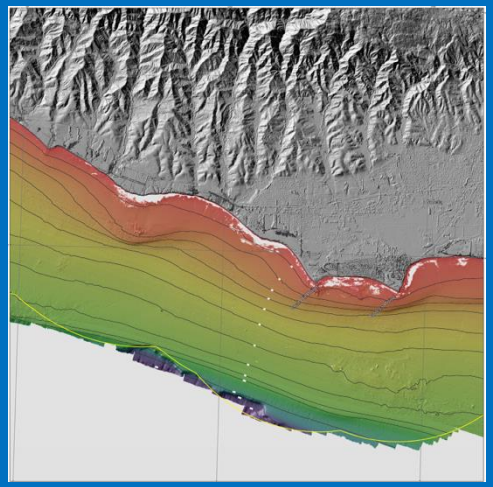
U.S. Geological Survey, Pacific Coastal and Marine Science Center, 2885 Mission St., Santa Cruz, California, 95060, USA



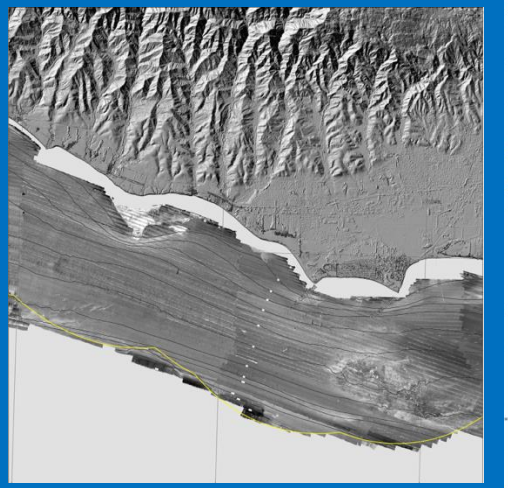


SB Channel data: Multibeam bathymetry and backscatter, camera sled video and photography, ~160 seismic profiles (>1,300 km) mostly mini-sparker, some CHIRP, 1-1.5 km line spacing with ties) – ALL PUBLICLY AVAILABLE

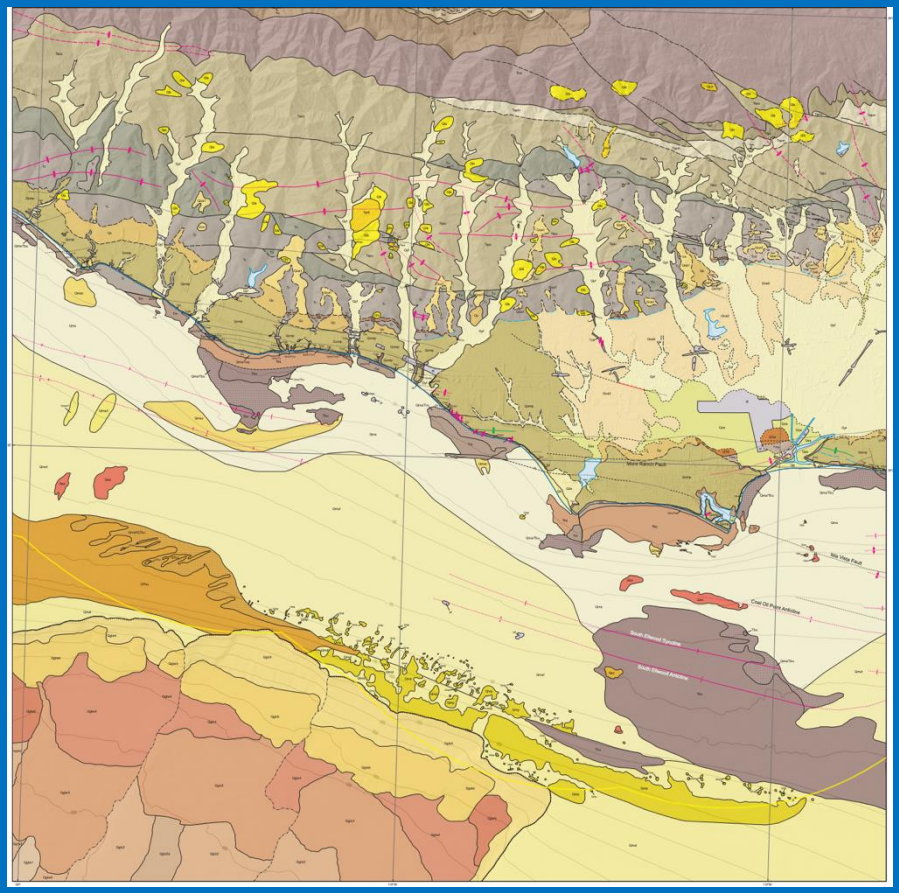
Offshore of Coal Oil Point (12 map sheets, 57 p. pamphlet)



Color bathymetry

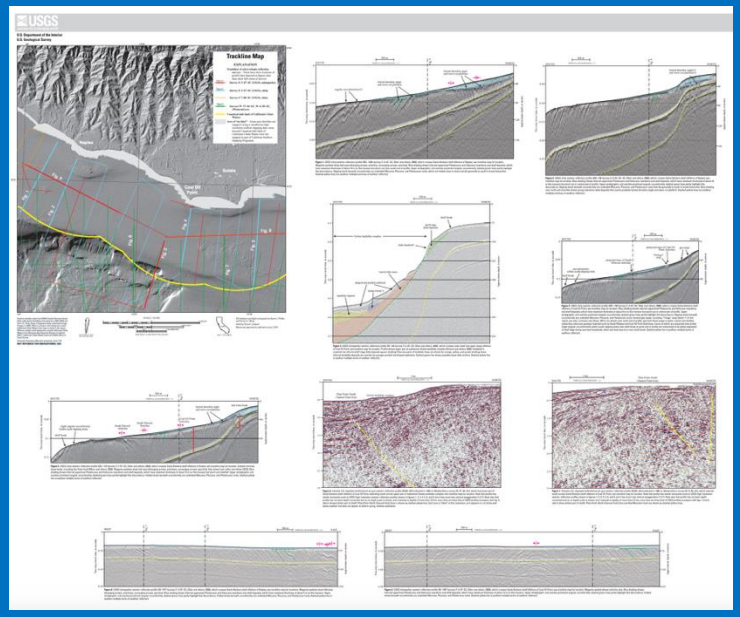


Acoustic backscatter



Onshore-offshore geology (with CGS)

+ gray-scale bathy, perspective views, groundtruthing imagery, habitat and seafloor character, sediment distribution and thickness, oil seeps



Seismic-reflection profiles (new & legacy)

8 mapping blocks, 86 map sheets

30 co-authors, 6 institutions

Research Paper

GEOSPHERE

GEOSPHERE; v. 13, no. 6

doi:10.1130/GES01387.1

25 figures; 2 tables

Shelf evolution along a transpressive transform margin, Santa Barbara Channel, California

Samuel Y. Johnson[1], Stephen R. Hartwell[1], Christopher C. Sorlien[2], Peter Dartnell[1], and Andrew C. Ritchie[1]

[1]U.S. Geological Survey, Pacific Coastal and Marine Science Center, 2885 Mission St., Santa Cruz, California 95060, USA

[2]Earth Research Institute, University of California, 6832 Ellison Hall, Santa Barbara, California 93106, USA

Mid-Channel Anticline

Montalvo Fault

Oak Ridge Fault

Ventura-Pitas Point-

Fault & Rincon Anticline

at Pitas Point

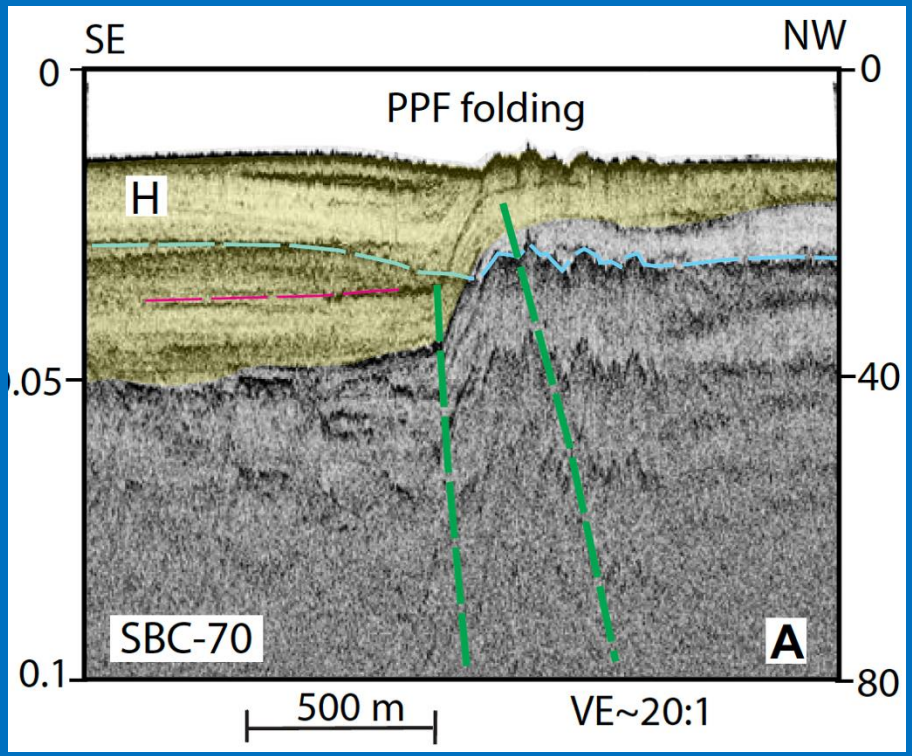
Red Mountain Fault

Rincon Creek Fault

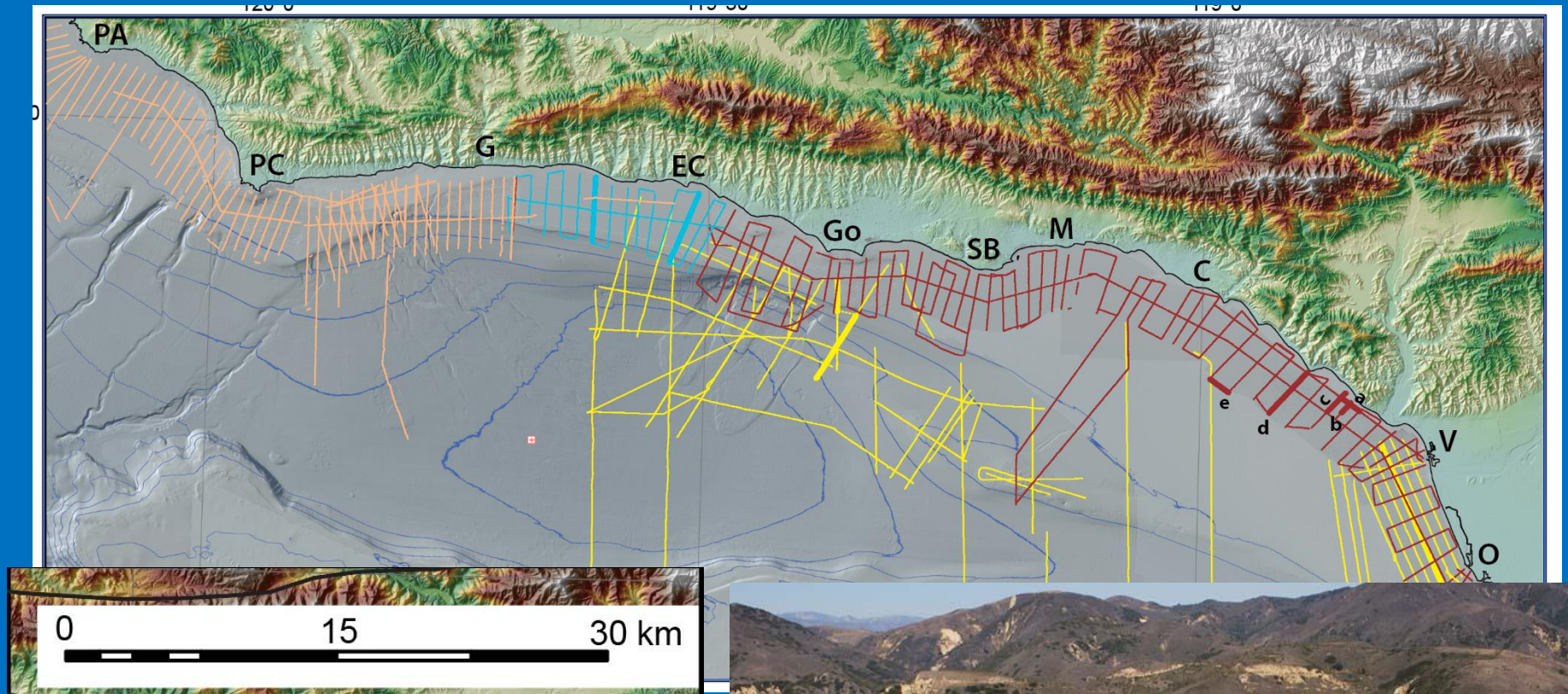
Isla Vista Fault

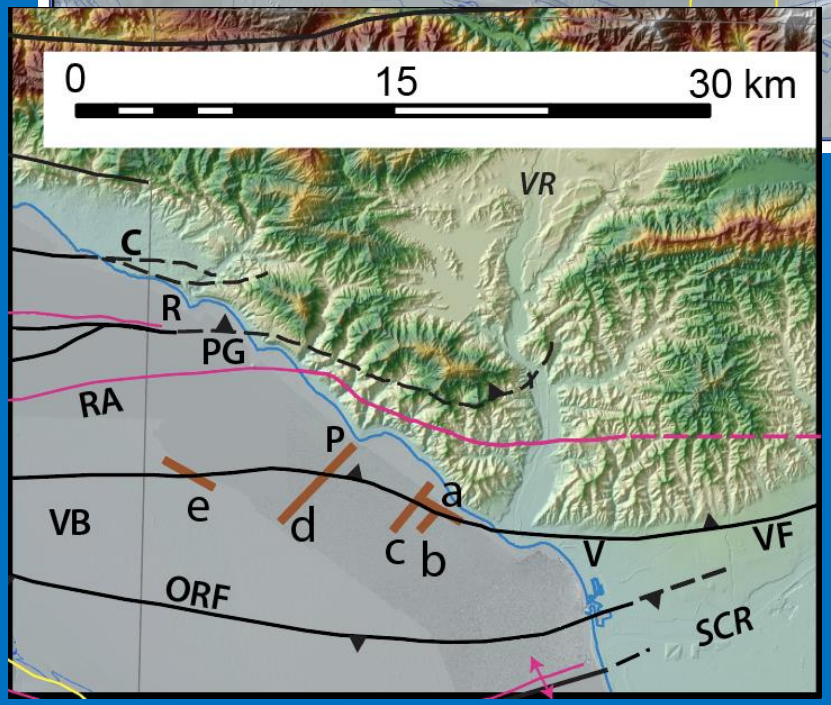
West of Coal Oil Point Discontinuity

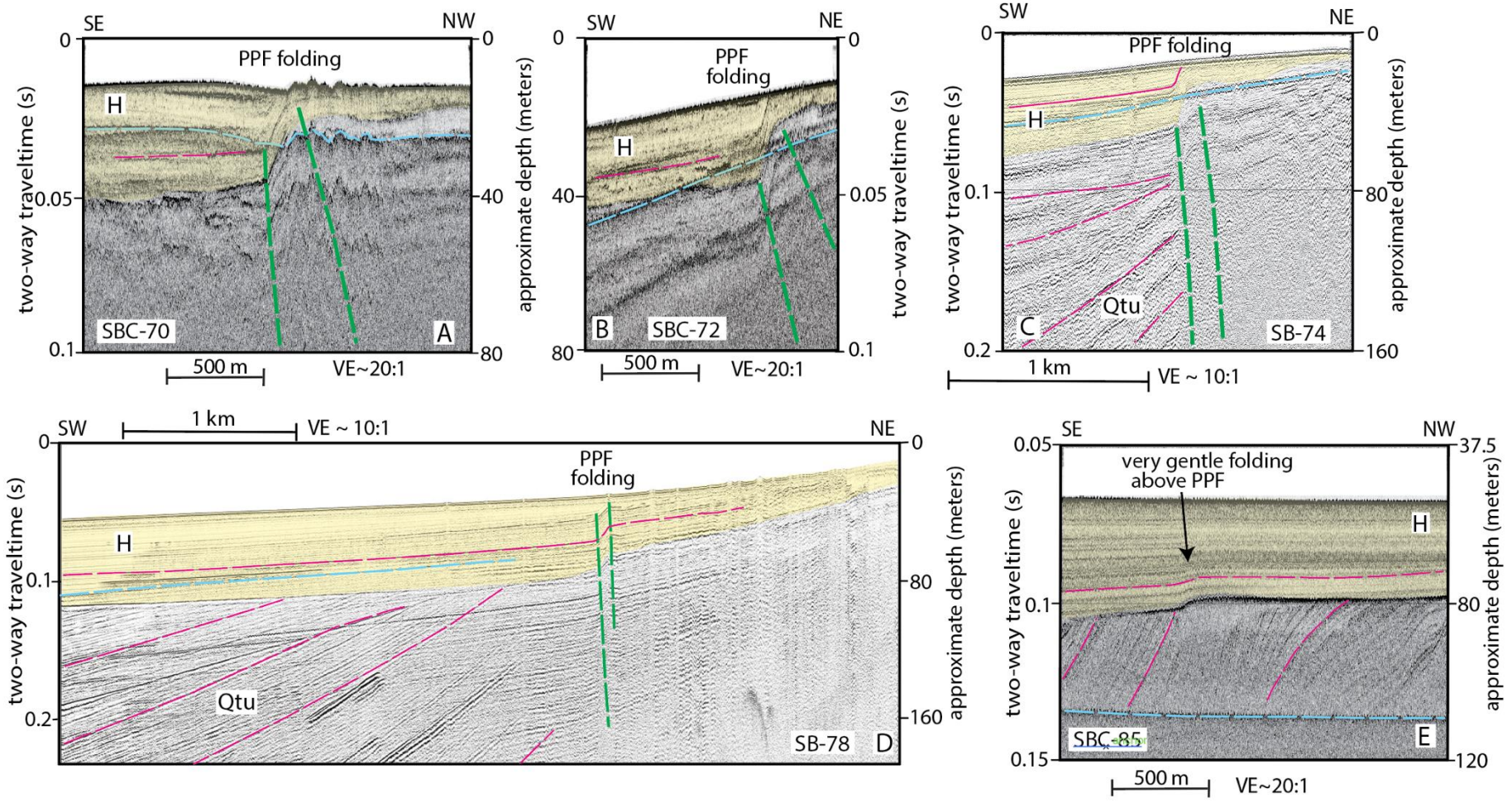
South Branch of Santa Ynez Fault



Western SB shelf uplift, above North Channel fault


PA
PC
G
EC
Go
SB
M
C
e
d
c
b
a
V
O


0
15
30 km
VR
C
R
PG
RA
P
e
d
a
c
b
V
VF
VB
ORF
SCR



A, B, C - 3-4 km west of Ventura "landing," 21-25 m fold relief

D – 8 km west of "Ventura landing" (Pitas Point), 12 m fold relief

E – 14 km west of "Ventura landing", 2 m fold relief

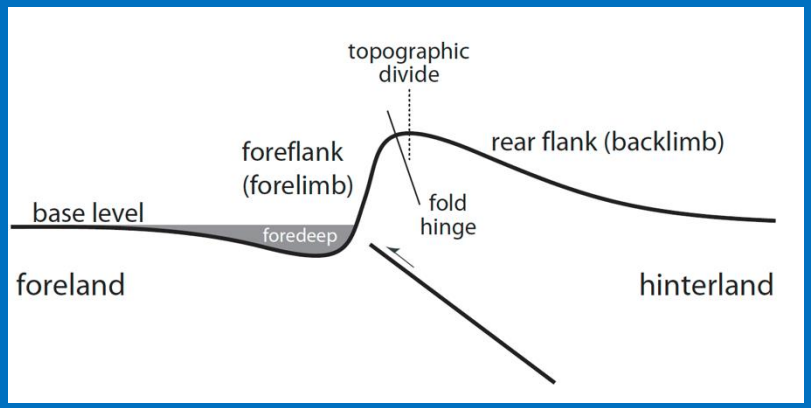
Additional structural relief on coastal terraces and Ventura anticline;

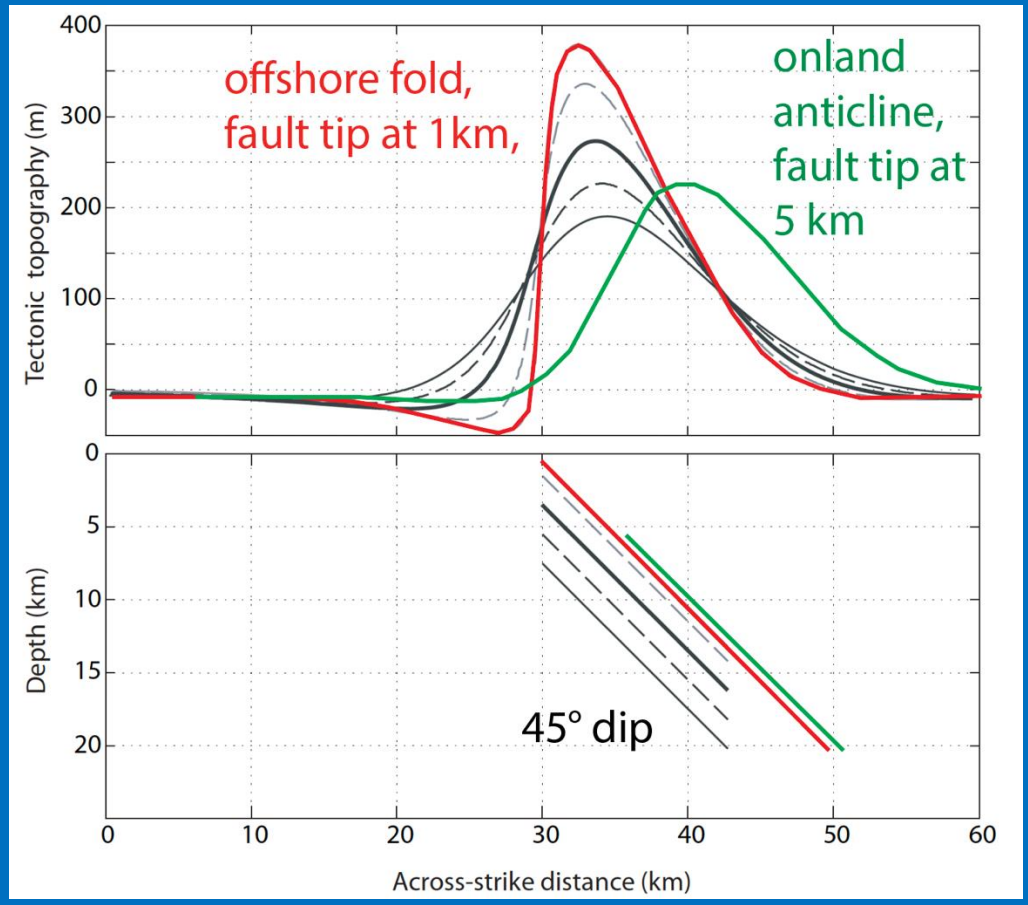
Partitioning due to increased depth of fault tip, variation in rupture depth - other faults involved?

Geological Society of America Special Papers

First-order topography over blind thrusts

Michael A. Ellis and Alexander L. Densmore 2006



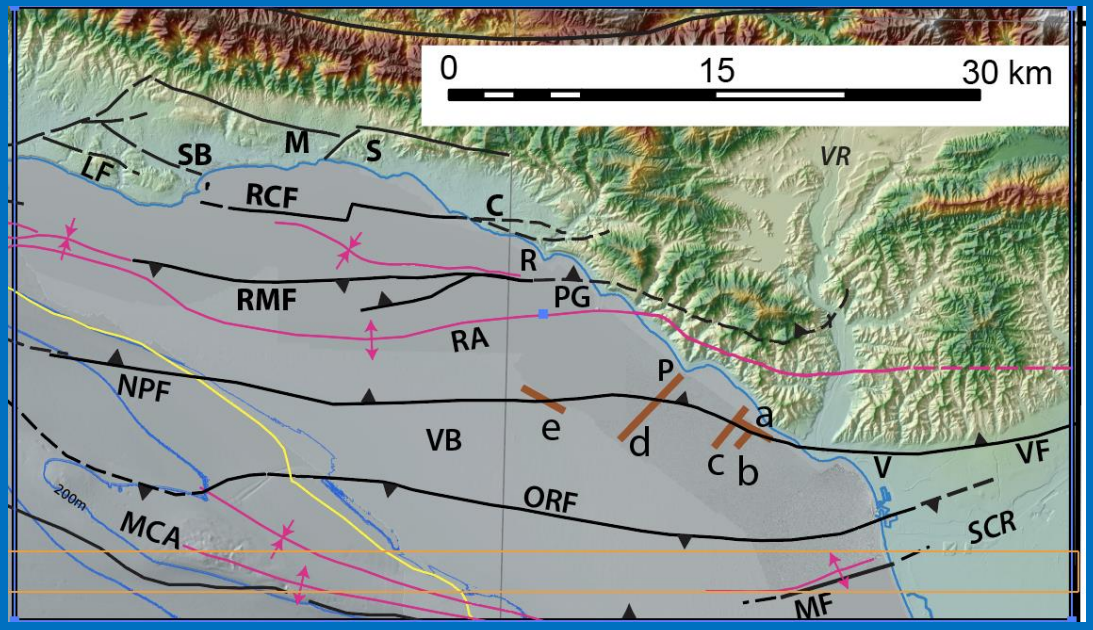


Concept:
Fault Tip vs.
Event
"Rupture Tip"

Frontiers in Earth Science, 2021

Faulting and Folding of the Transgressive Surface Offshore Ventura Records Deformational Events in the Holocene

Hector Perea[1,2,3], Gülsen Ucarkus[4], Neal Driscoll[2], Graham Kent[5], Yuval Levy[2,6] and Thomas Rockwell[6]*



Next talk will present additional data from this area. Uses CHIRP data set to identify 3 to 4 deformational events with vertical uplifts ranging from 1 to 10 m. Some mapping differences north of PPF (RMF, RCF) – not discussed today

Geochemistry, Geophysics, Geosystems

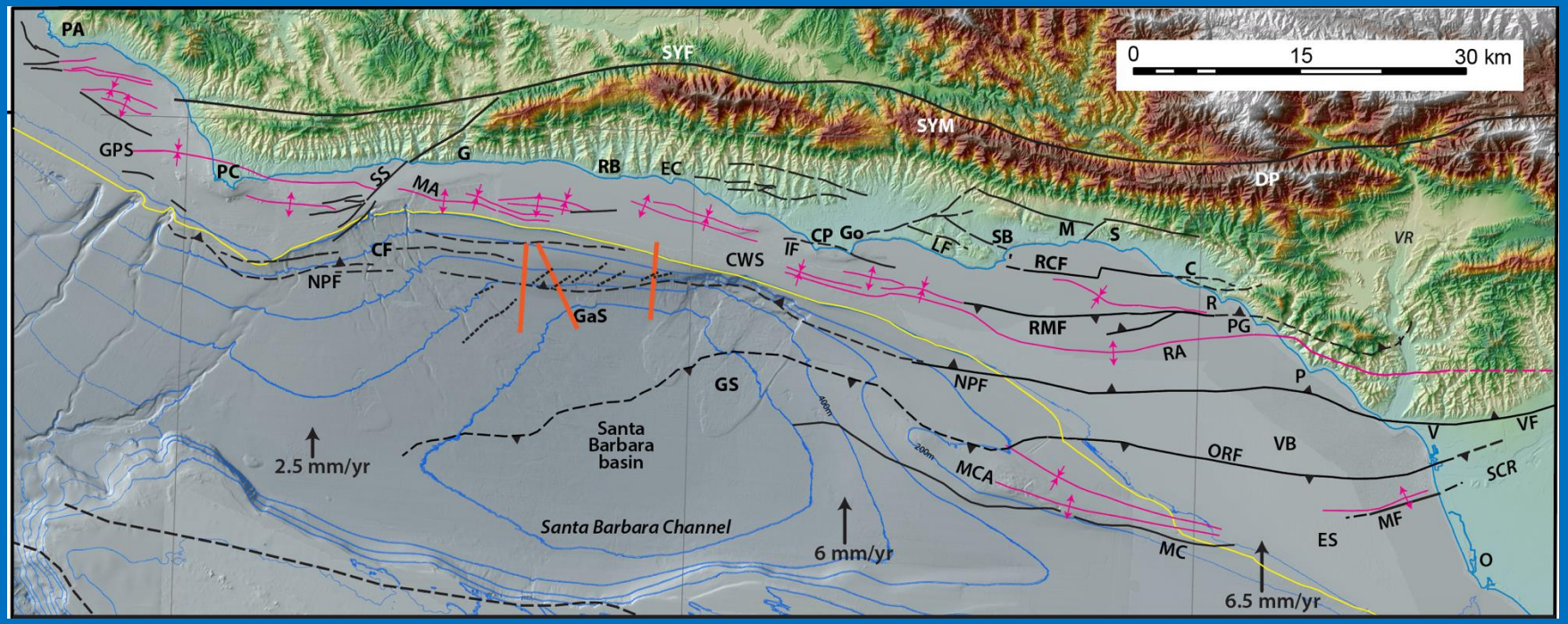
RESEARCH ARTICLE
10.1029/2020GC009055

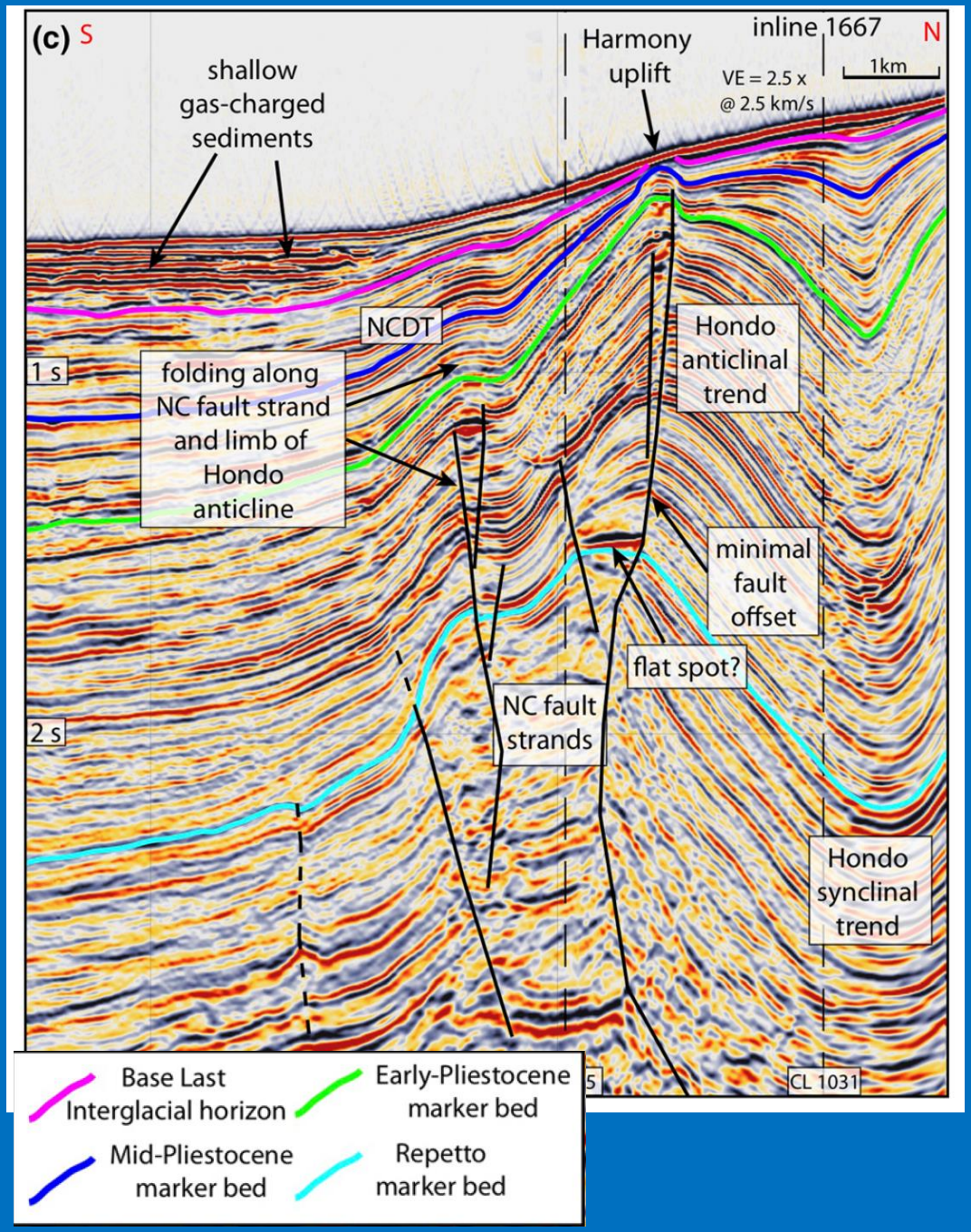
Structural Controls on Slope Failure Within the Western Santa Barbara Channel Based on 2-D and 3-D Seismic Imaging

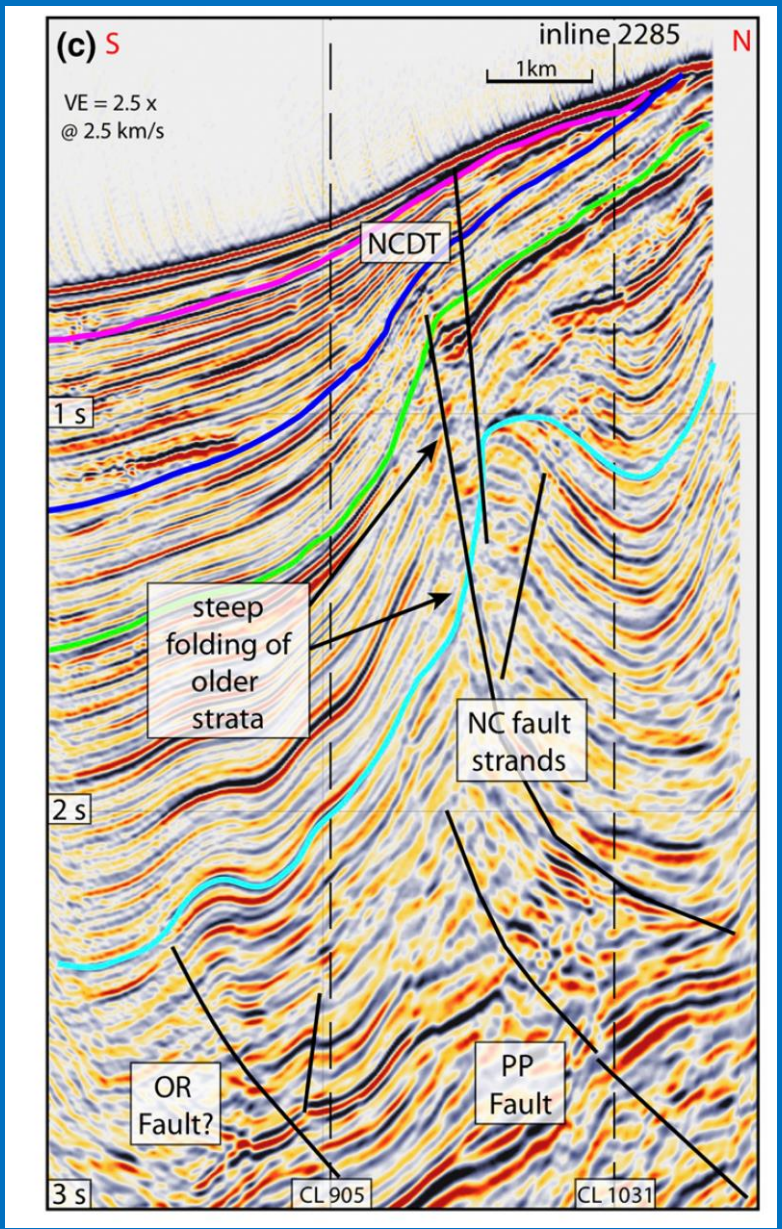
Jared W. Kluesner[1], Daniel S. Brothers[1], Alexis L. Wright[2], and Samuel Y. Johnson[1]

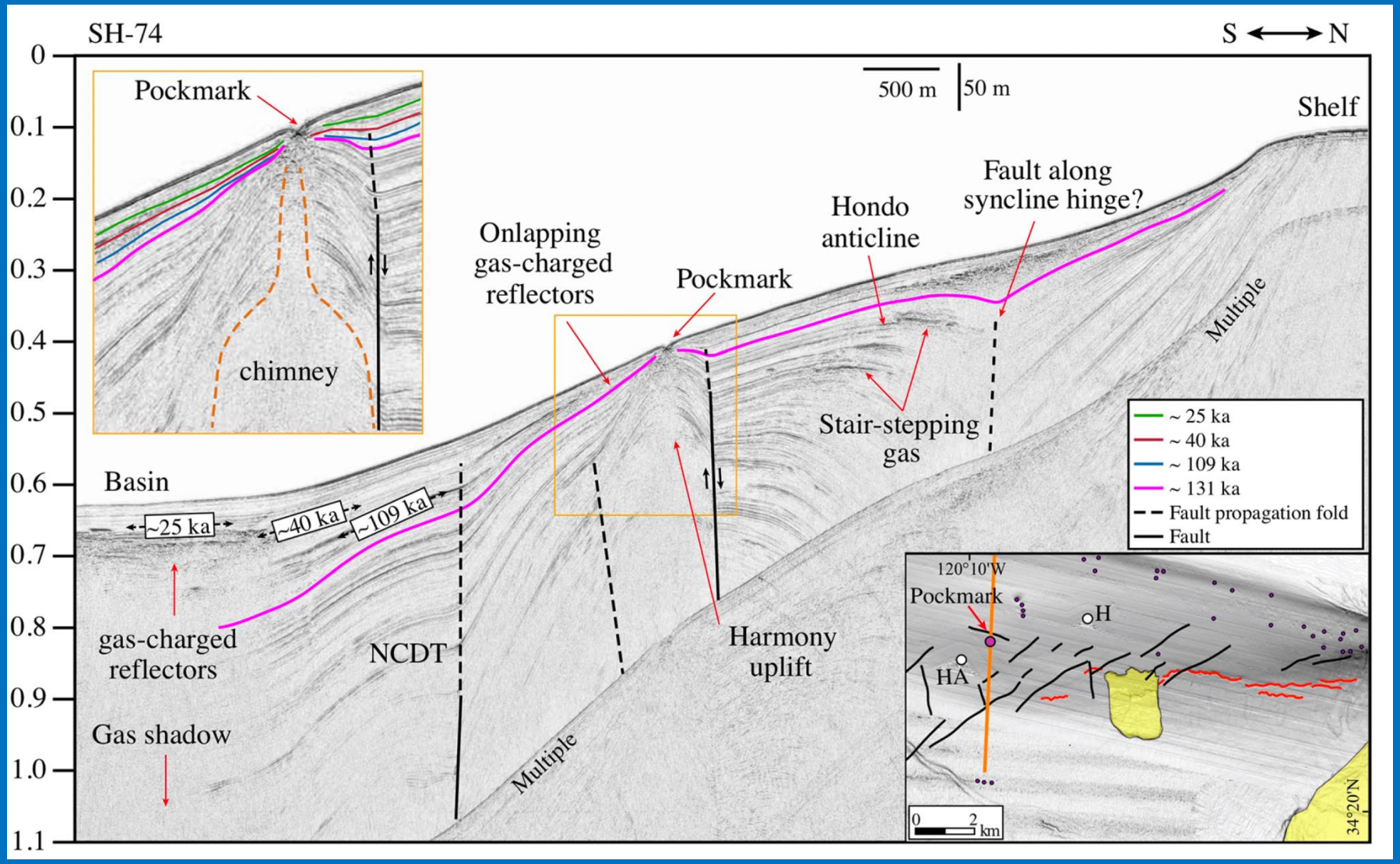
Key Points:

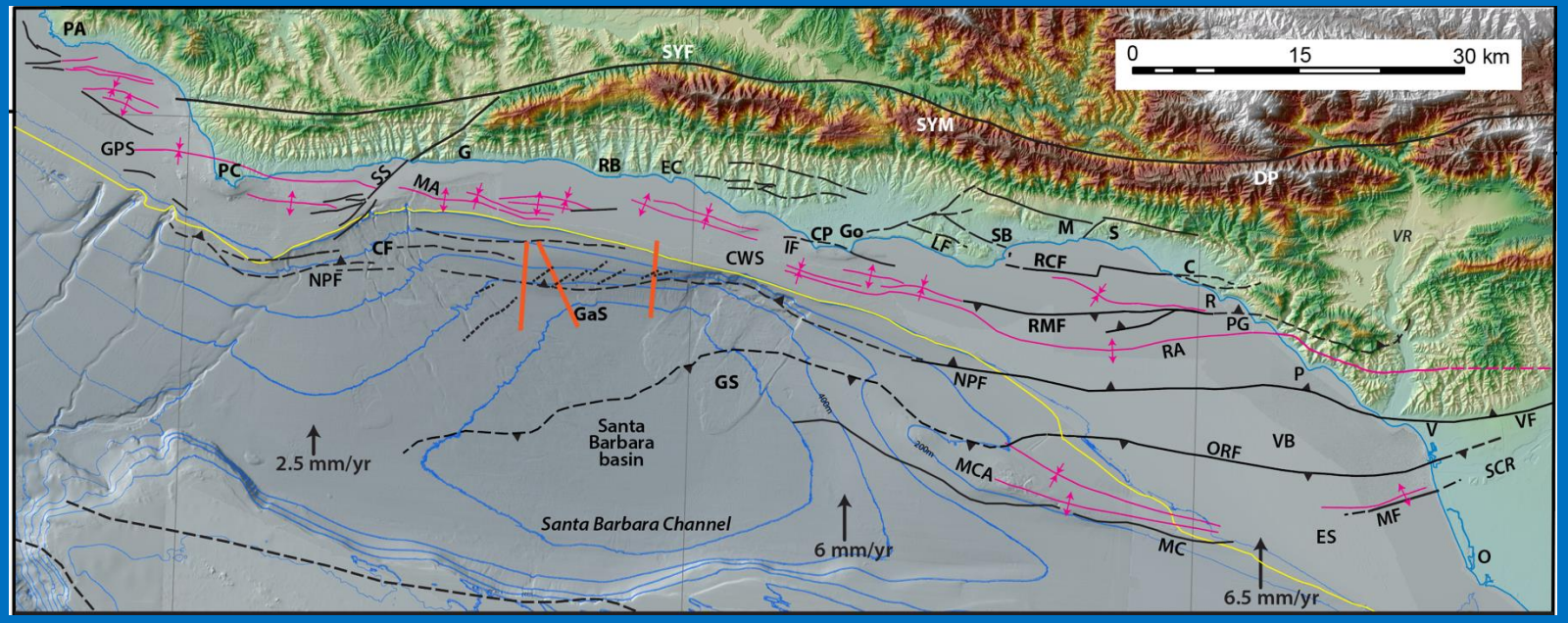
- This study uses a suite marine geophysical data to examine the structural controls on slope failure in the Santa Barbara Channel

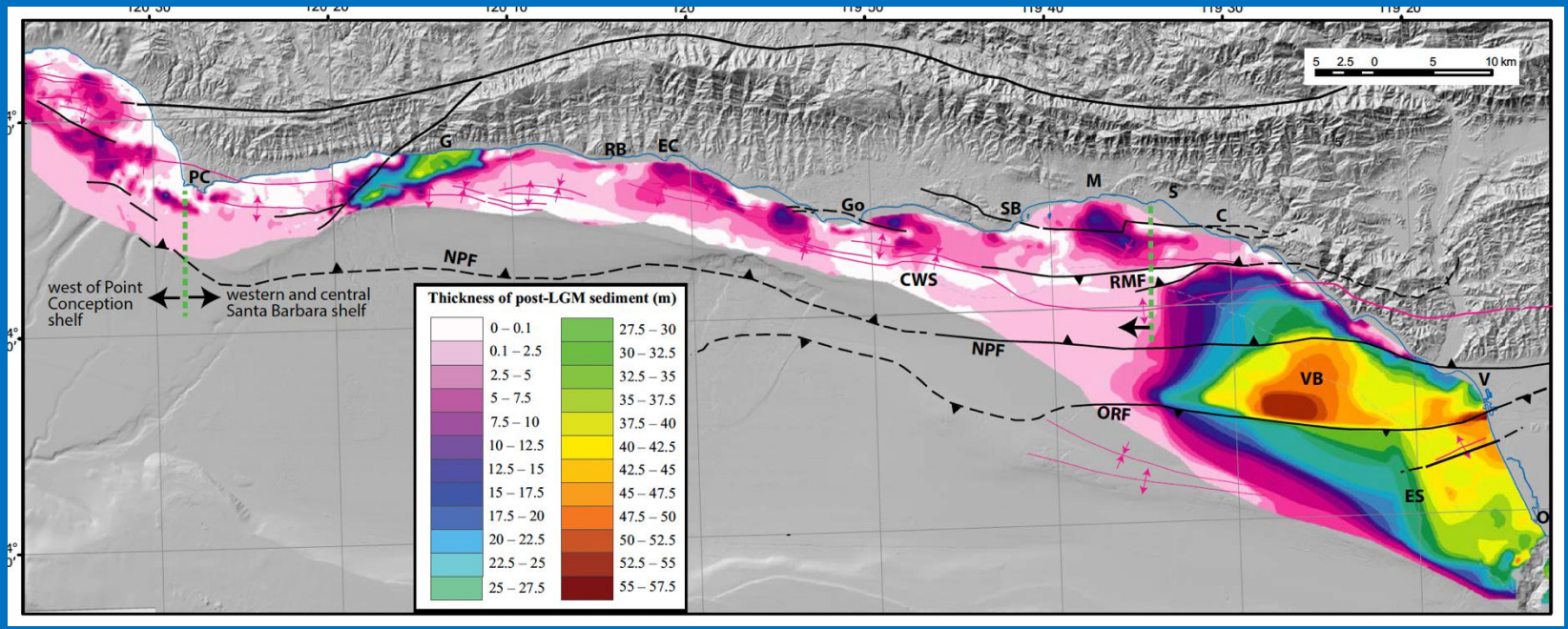


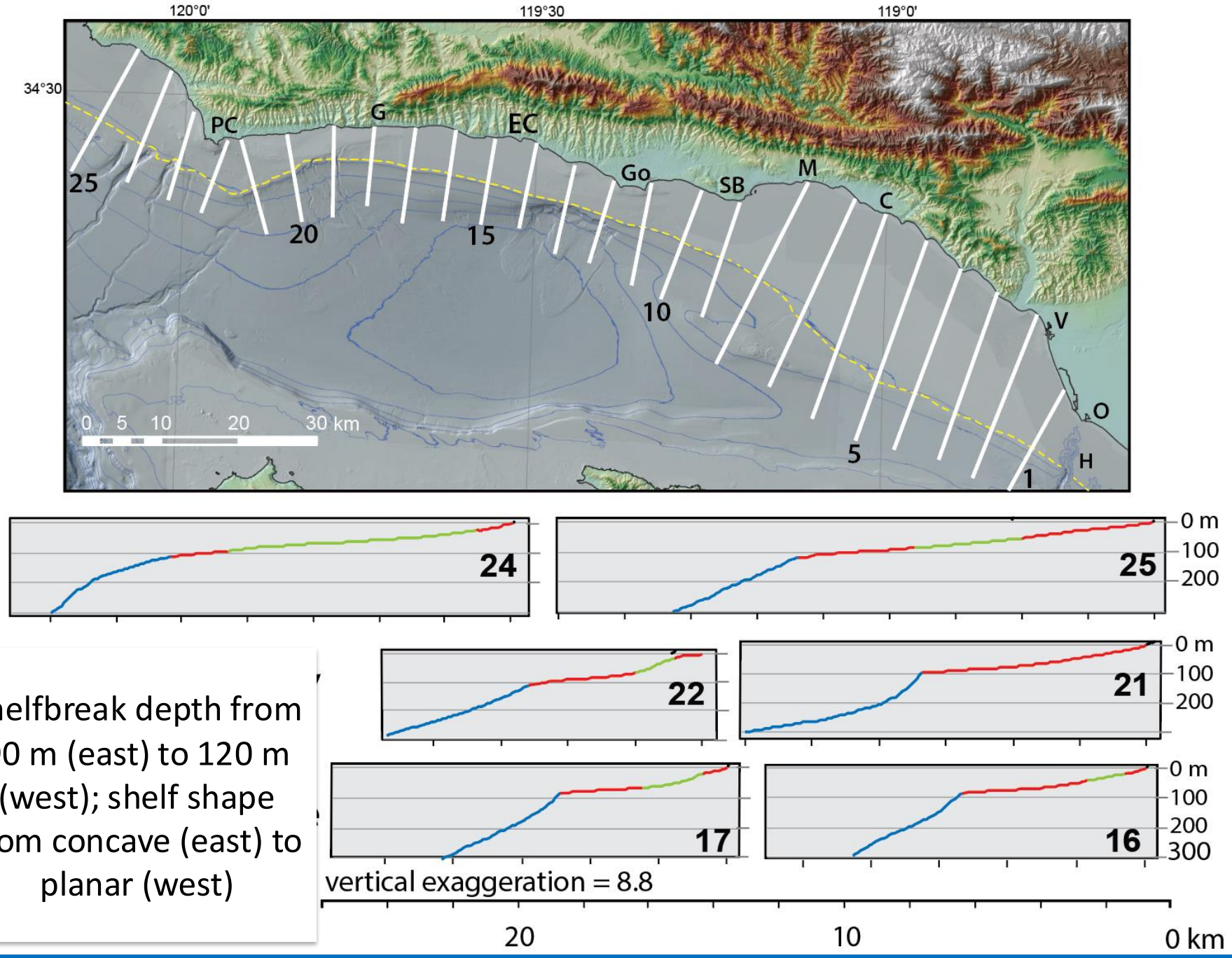

(c) S
inline 1667
N
Harmony uplift
shallow gas-charged sediments
VE = 2.5 x @ 2.5 km/s
1km
NCDT
1 s
folding along NC fault strand and limb of Hondo anticline
Hondo anticlinal trend
minimal fault offset
flat spot?
NC fault strands
2 s
Hondo synclinal trend
CL 1031
Base Last Interglacial horizon
Early-Pliestocene marker bed
Mid-Pliestocene marker bed
Repetto marker bed


(c) S
inline 2285
N
1km
VE = 2.5 x @ 2.5 km/s
NCDT
1 s
steep folding of older strata
NC fault strands
2 s
OR Fault?
PP Fault
3 s
CL 905
CL 1031


SH-74
S ⟷ N
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Pockmark
chimney
500 m
50 m
Shelf
Fault along syncline hinge?
Hondo anticline
Onlapping gas-charged reflectors
Pockmark
Multiple
Stair-stepping gas
~ 25 ka
~ 40 ka
~ 109 ka
~ 131 ka
Fault propagation fold
Fault
Basin
~25 ka
~40 ka
~109 ka
gas-charged reflectors
NCDT
Harmony uplift
Gas shadow
Multiple
120°10'W
Pockmark
H
HA
0
2
km
34°20'N

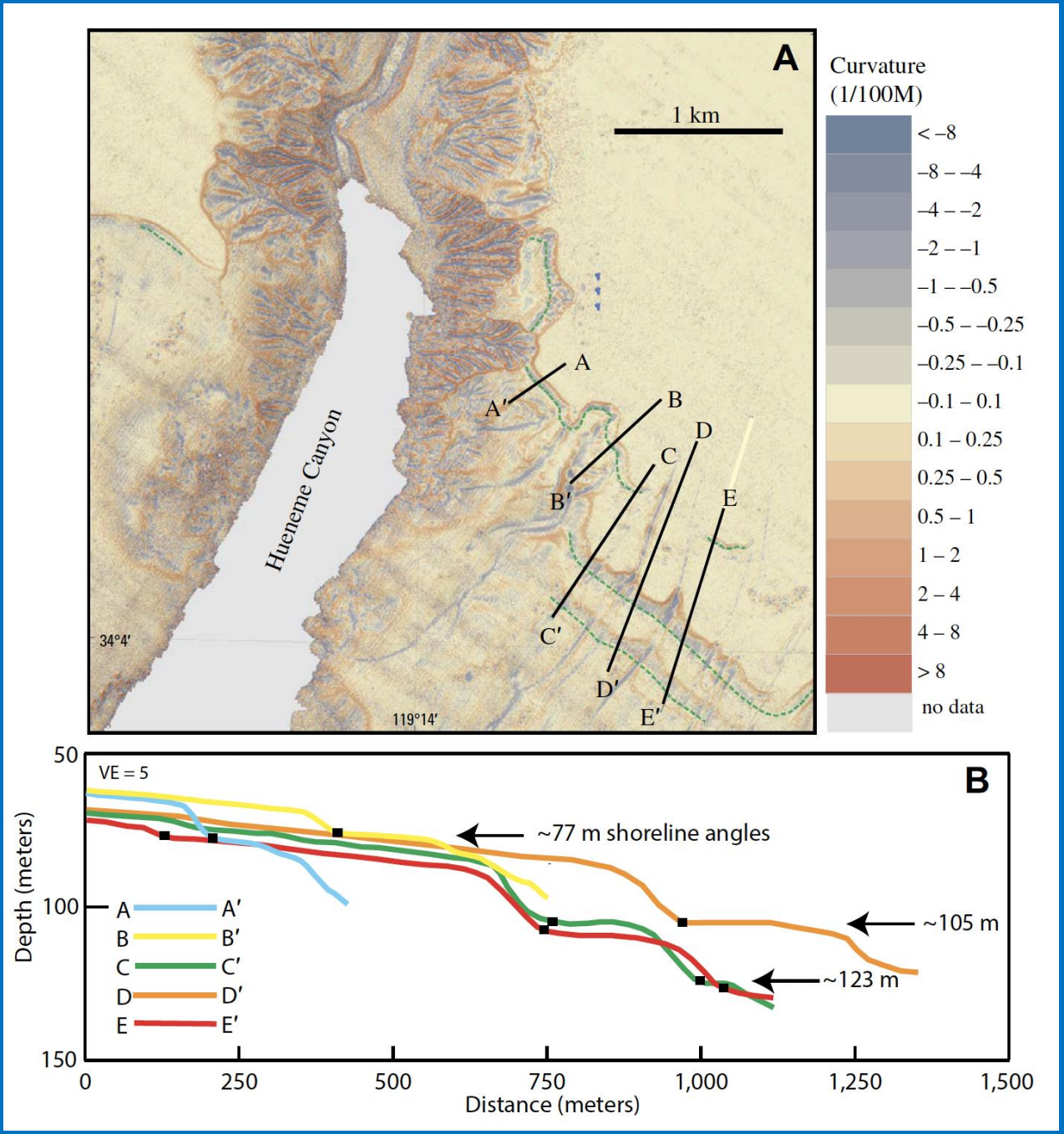

PA
SYF
SYM
0
15
30 km
GPS
PC
SS
MA
G
RB
EC
DP
CP
Go
IF
LF
SB
M
S
VR
CWS
RCF
C
CF
NPF
R
RMF
PG
GaS
RA
GS
NPF
P
Santa
Barbara
basin
2.5 mm/yr
ORF
VB
V
VF
MCA
SCR
MF
Santa Barbara Channel
6 mm/yr
MC
ES
O
6.5 mm/yr

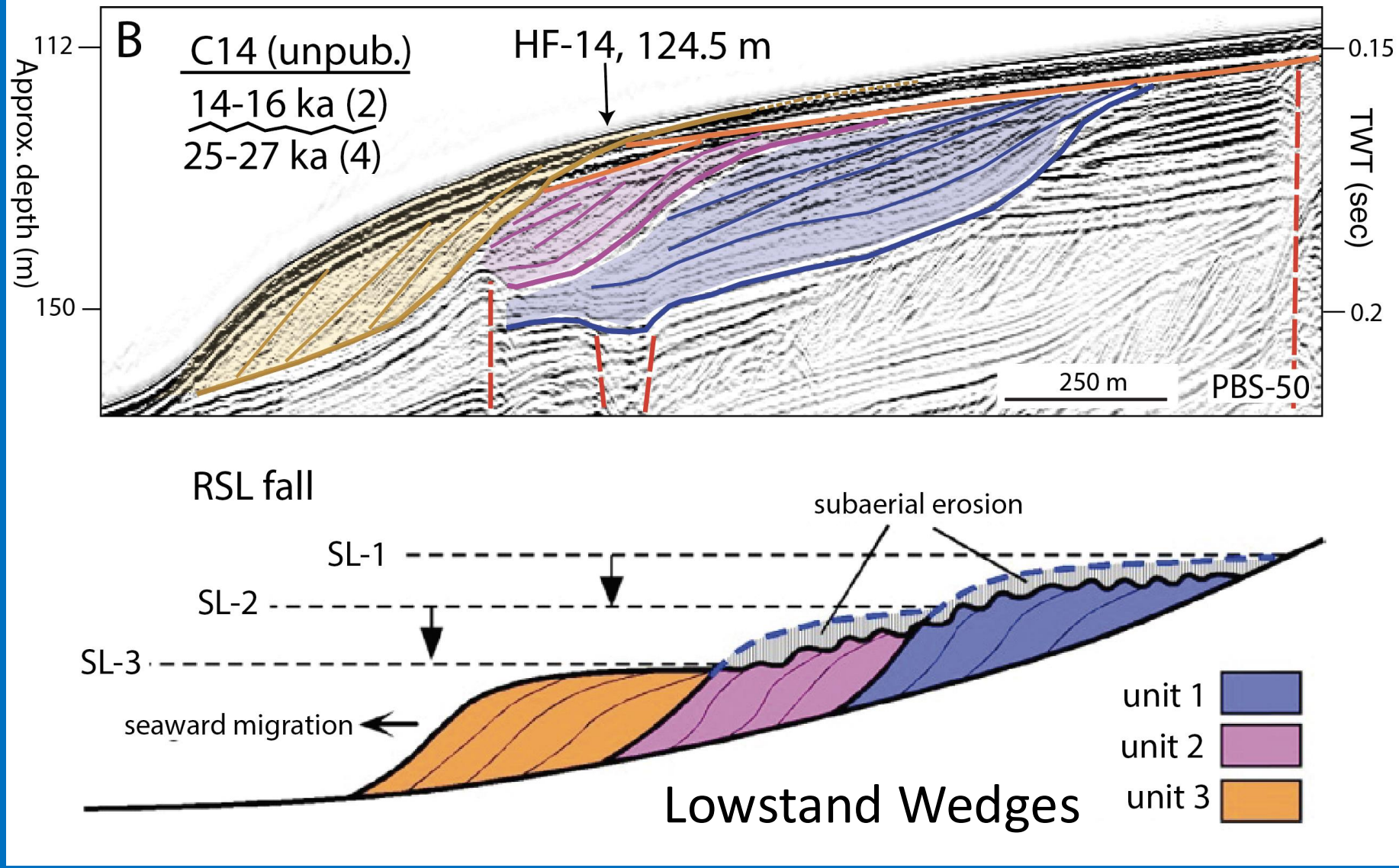

5 2.5 0 5 10 km
G
RB
EC
PC
M
S
Go
SB
C
NPF
CWS
RMF
west of Point
Conception
shelf
western and central
Santa Barbara shelf
Thickness of post-LGM sediment (m)
0 – 0.1
0.1 – 2.5
2.5 – 5
5 – 7.5
7.5 – 10
10 – 12.5
12.5 – 15
15 – 17.5
17.5 – 20
20 – 22.5
22.5 – 25
25 – 27.5
27.5 – 30
30 – 32.5
32.5 – 35
35 – 37.5
37.5 – 40
40 – 42.5
42.5 – 45
45 – 47.5
47.5 – 50
50 – 52.5
52.5 – 55
55 – 57.5
NPF
VB
V
ORF
ES
O

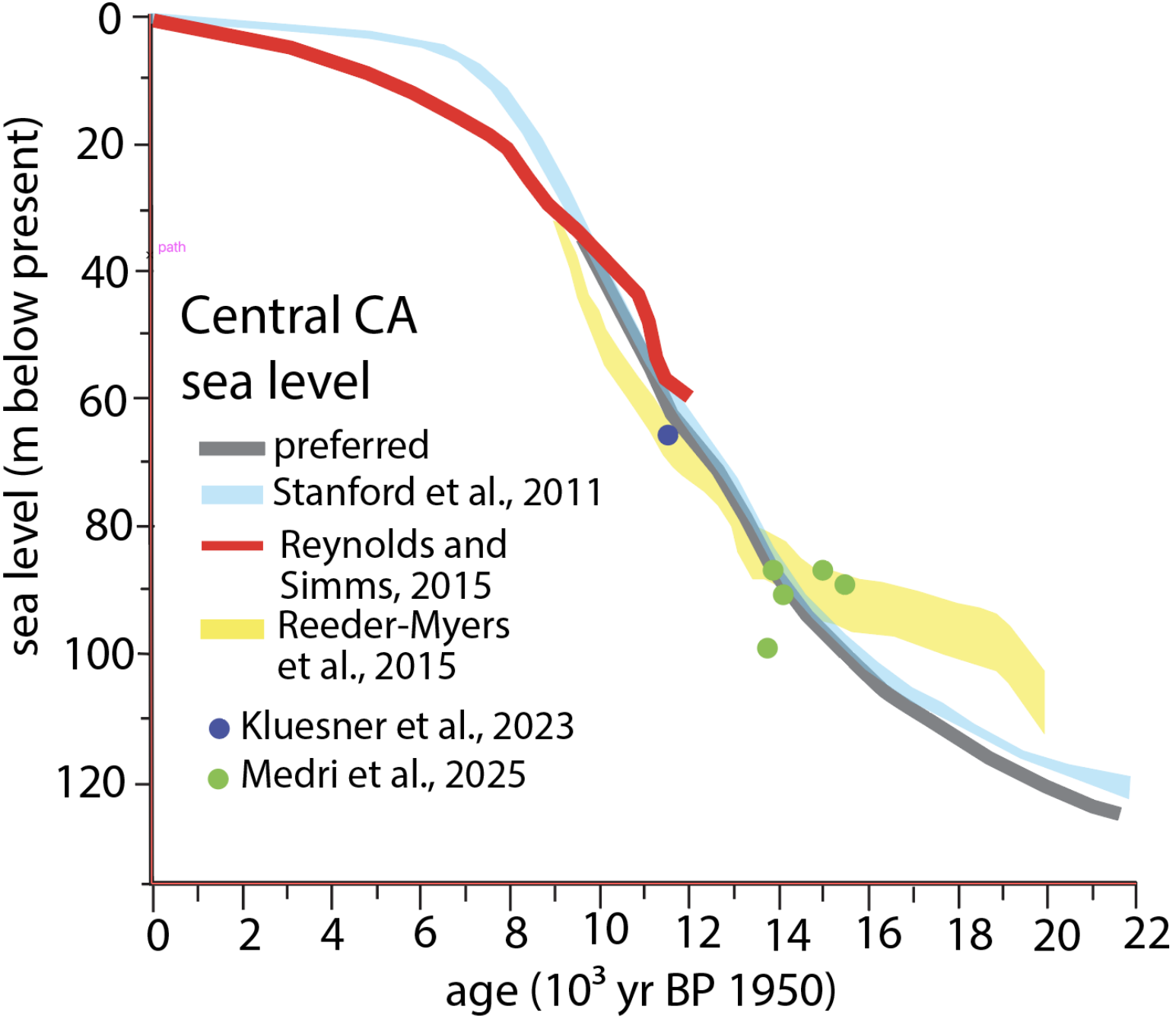


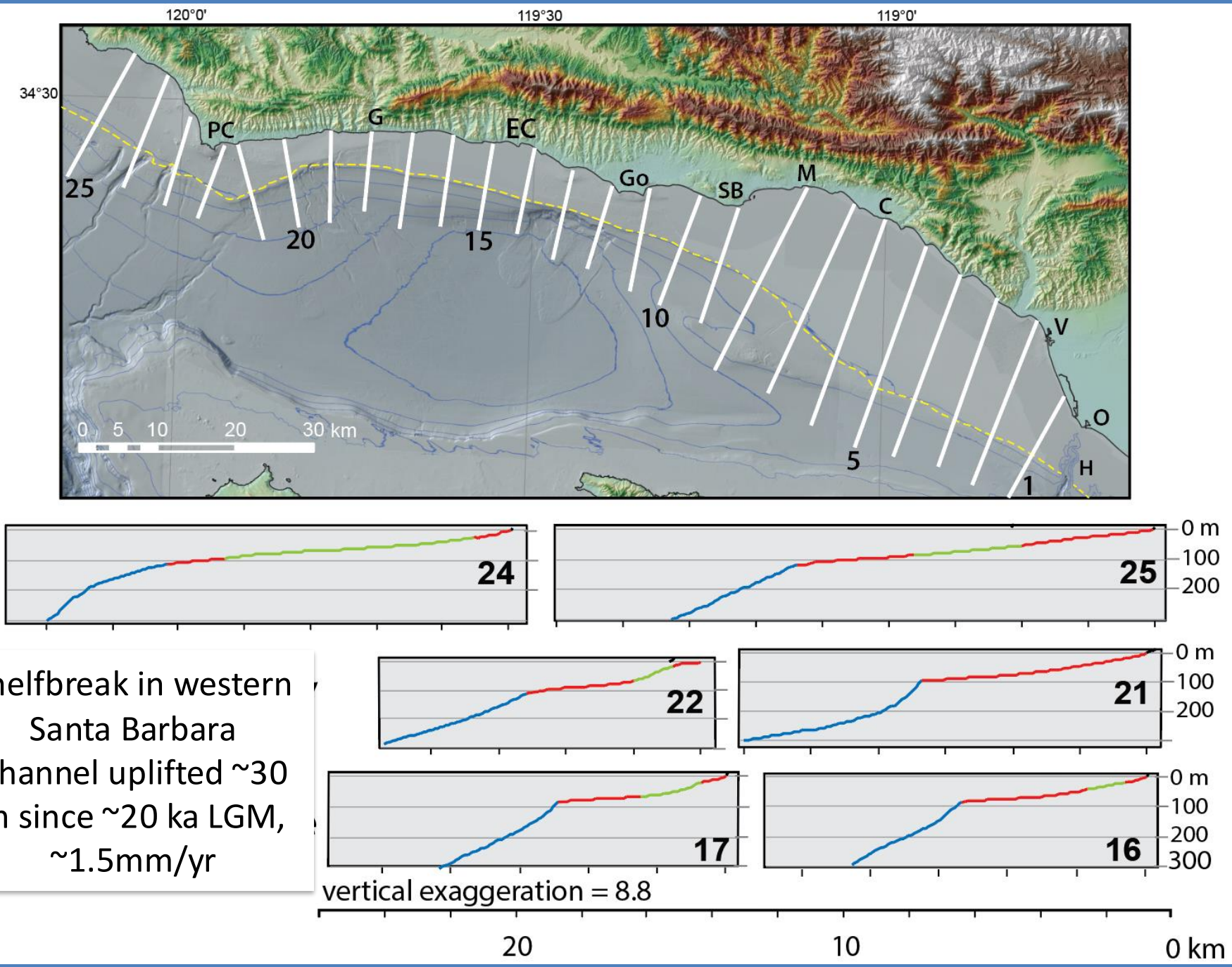
shelfbreak depth from 90 m (east) to 120 m (west); shelf shape from concave (east) to planar (west)

Hueneme Canyon, submerged terraces, risers, and shoreline angles




B
C14 (unpub.)
14-16 ka (2)
25-27 ka (4)
HF-14, 124.5 m
112
150
Approx. depth (m)
0.15
0.2
TWT (sec)
250 m
PBS-50
RSL fall
subaerial erosion
SL-1
SL-2
SL-3
seaward migration
unit 1
unit 2
unit 3
Lowstand Wedges


Central CA
sea level
preferred
Stanford et al., 2011
Reynolds and
Simms, 2015
Reeder-Myers
et al., 2015
Kluesner et al., 2023
Medri et al., 2025
sea level (m below present)
0
20
40
60
80
100
120
0
2
4
6
8
10
12
14
16
18
20
22
age (10^3 yr BP 1950)



shelfbreak in western Santa Barbara Channel uplifted ~30 m since ~20 ka LGM, ~1.5mm/yr

Conclusions

- Wealth of CSMP offshore bathymetric, seismic-reflection, sediment, seafloor imagery data publicly available at USGS, NOAA
- Offshore uplift at Pitas Point is poor match for onshore uplift, can be explained by variable location and depth of V-PP fault tip and "rupture tip"
- Western Santa Barbara Channel – 30 m of post-LGM (~20 ka) uplift of outer shelf and shelfbreak above NC-PP fault, ending at Point Conception