Width of Faulting Along Strike-Slip Faults

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Surface Fault Displacement Hazard Workshop, UC Berkeley, May 20-21, 2009

Primary Issues

Width of primary slip zone

Overall width of faulting, and the affect of warping in areas of thick sediment accumulation

Need to consider straight sections of fault differently than zones of complexity

Examples From:

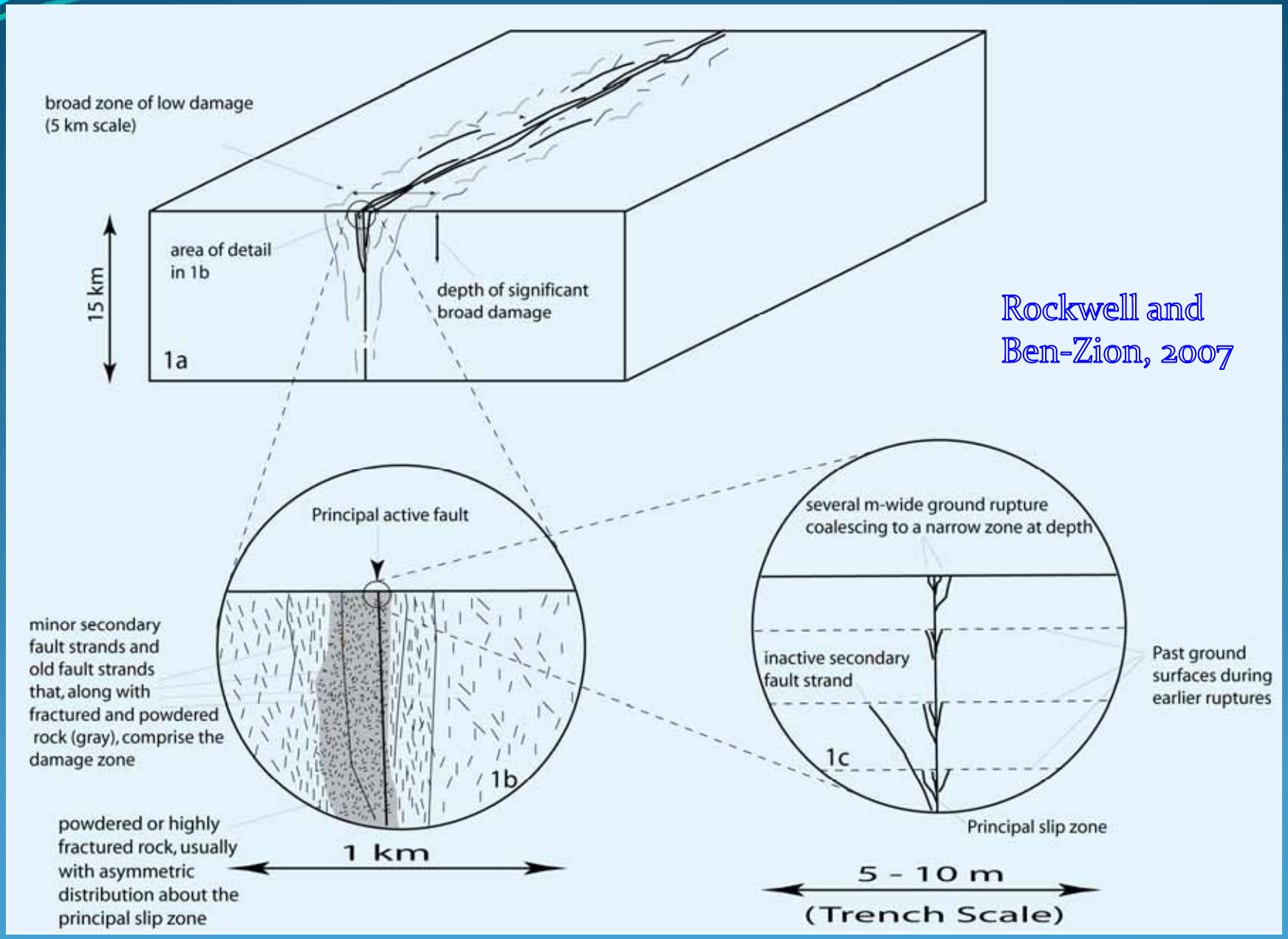
Mapping and Surveying of Surface Ruptures

Landers, Izmit, Imperial, Hector Mine

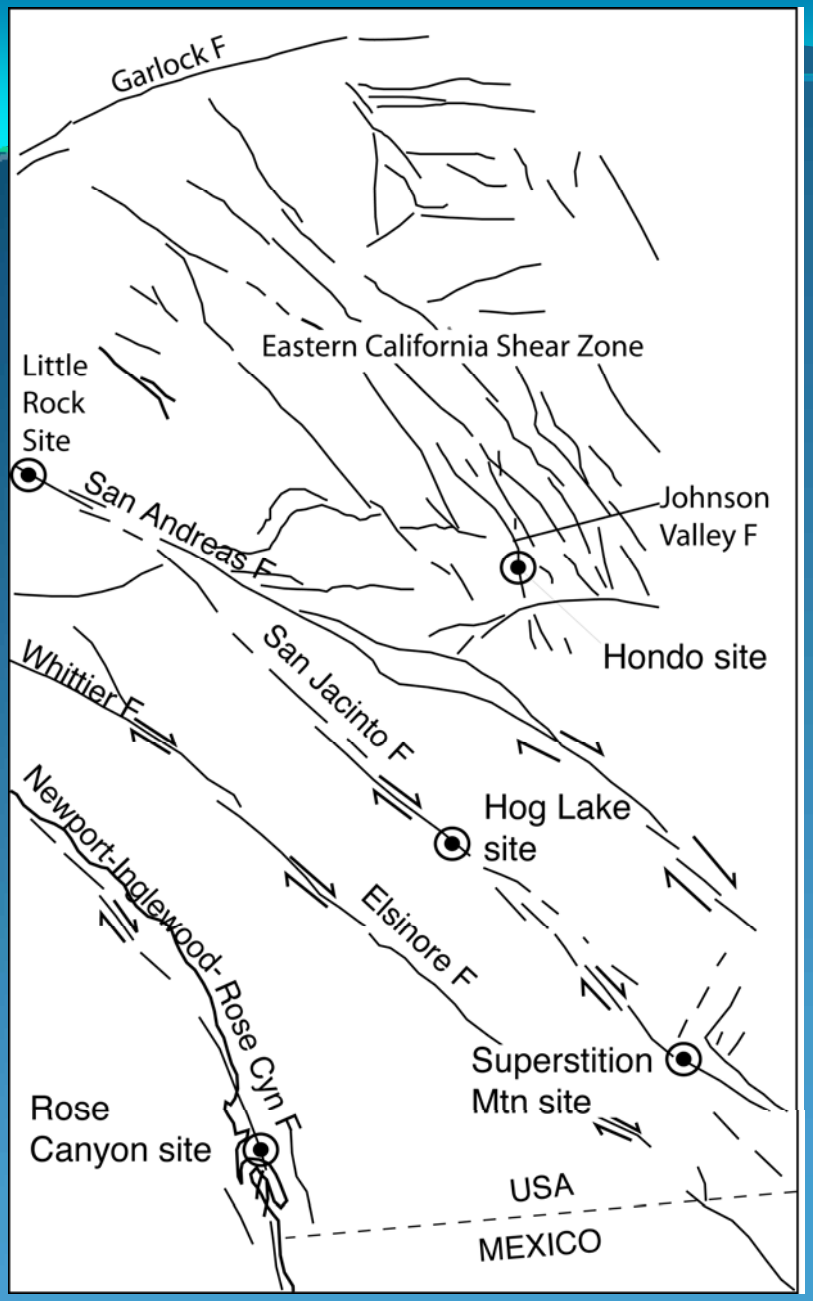
2D and 3D Trenching Across Faults

Landers, Izmit, Imperial, San Andreas, Rose Canyon, San Jacinto

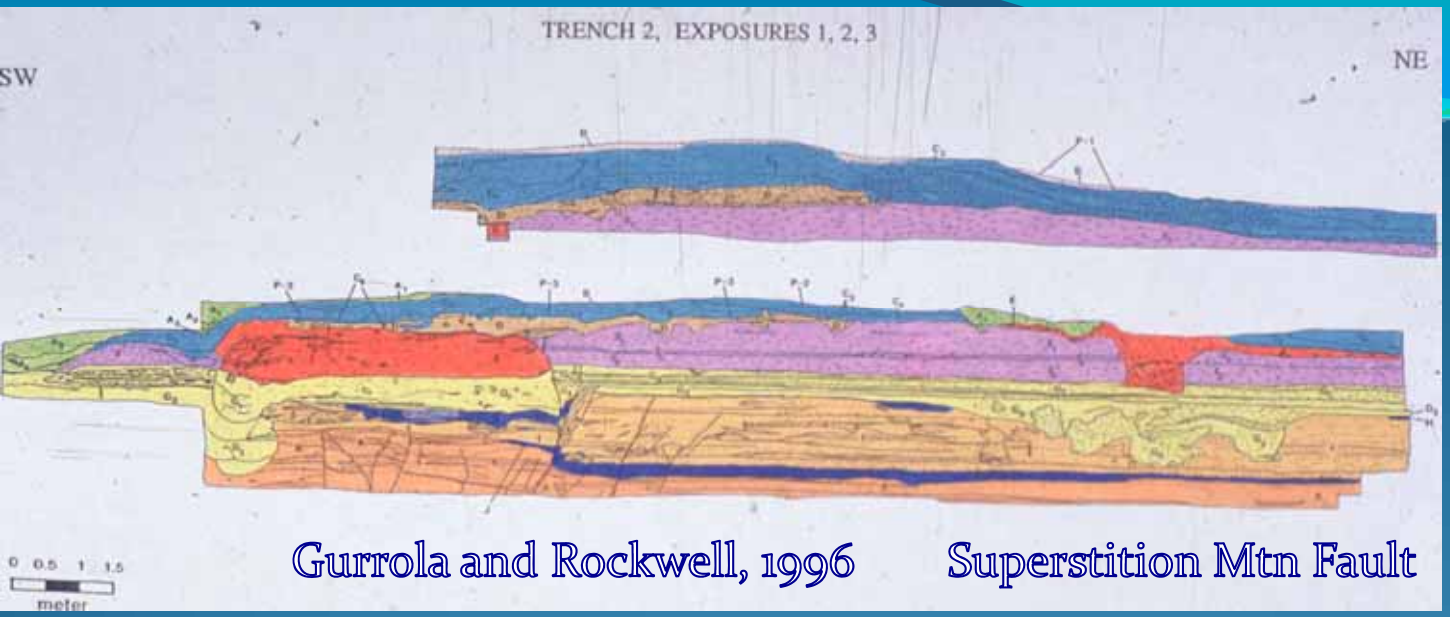
General observations on fault zone structure



Rockwell and Ben-Zion, 2007

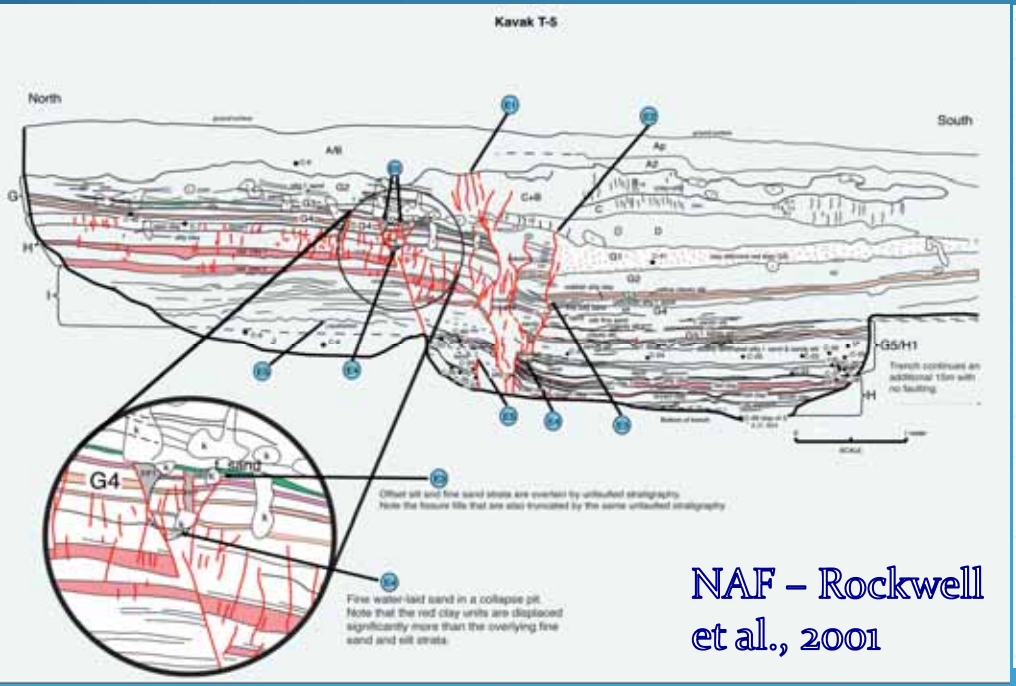


Slip width sites investigated

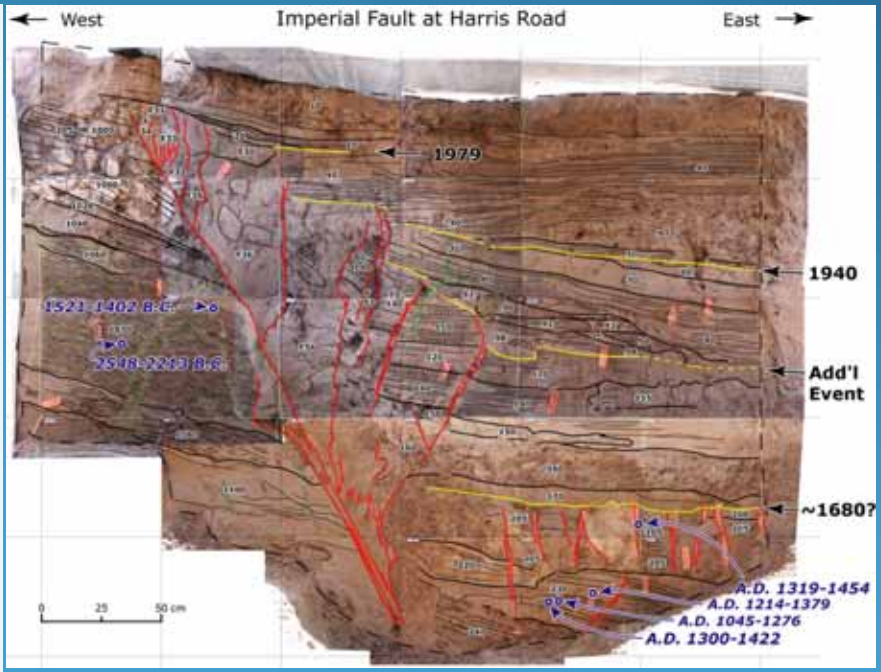


Gurrola and Rockwell, 1996 Superstition Mtn Fault

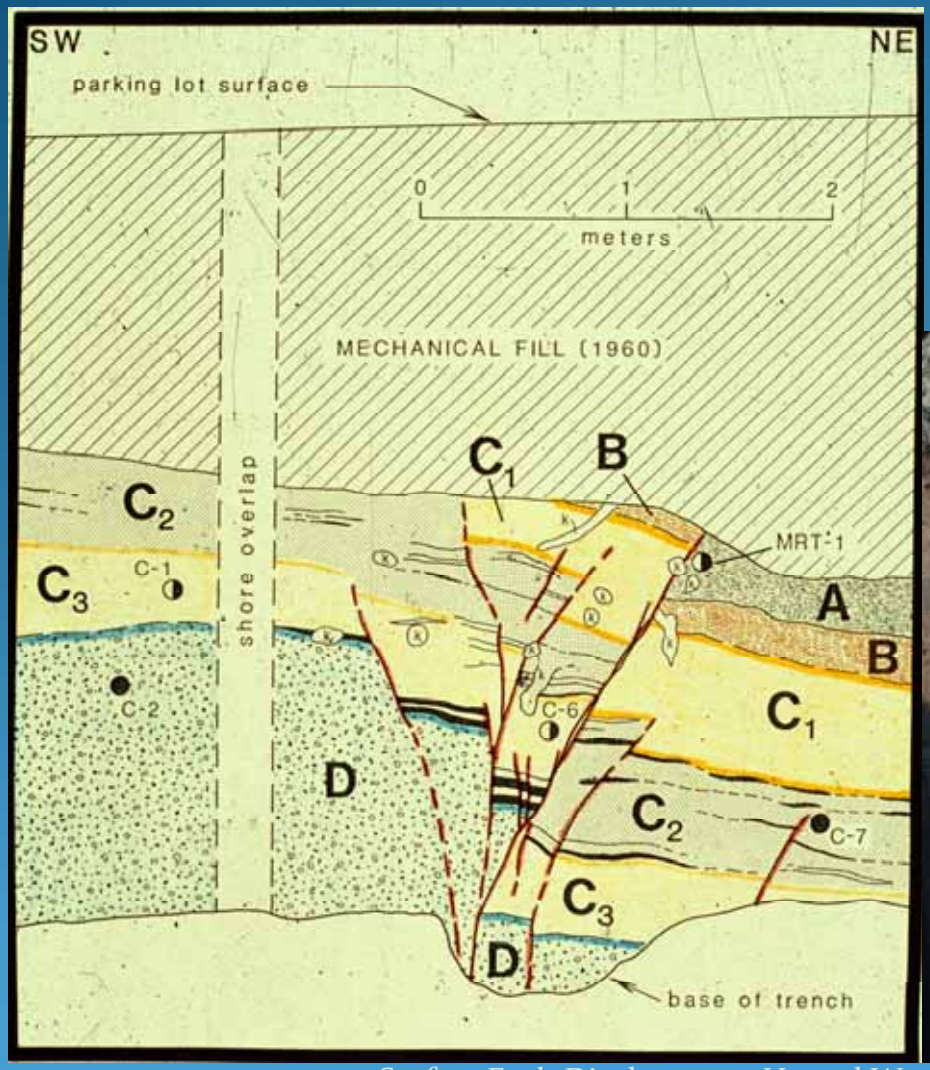
Broad zones at the surface narrow rapid with depth



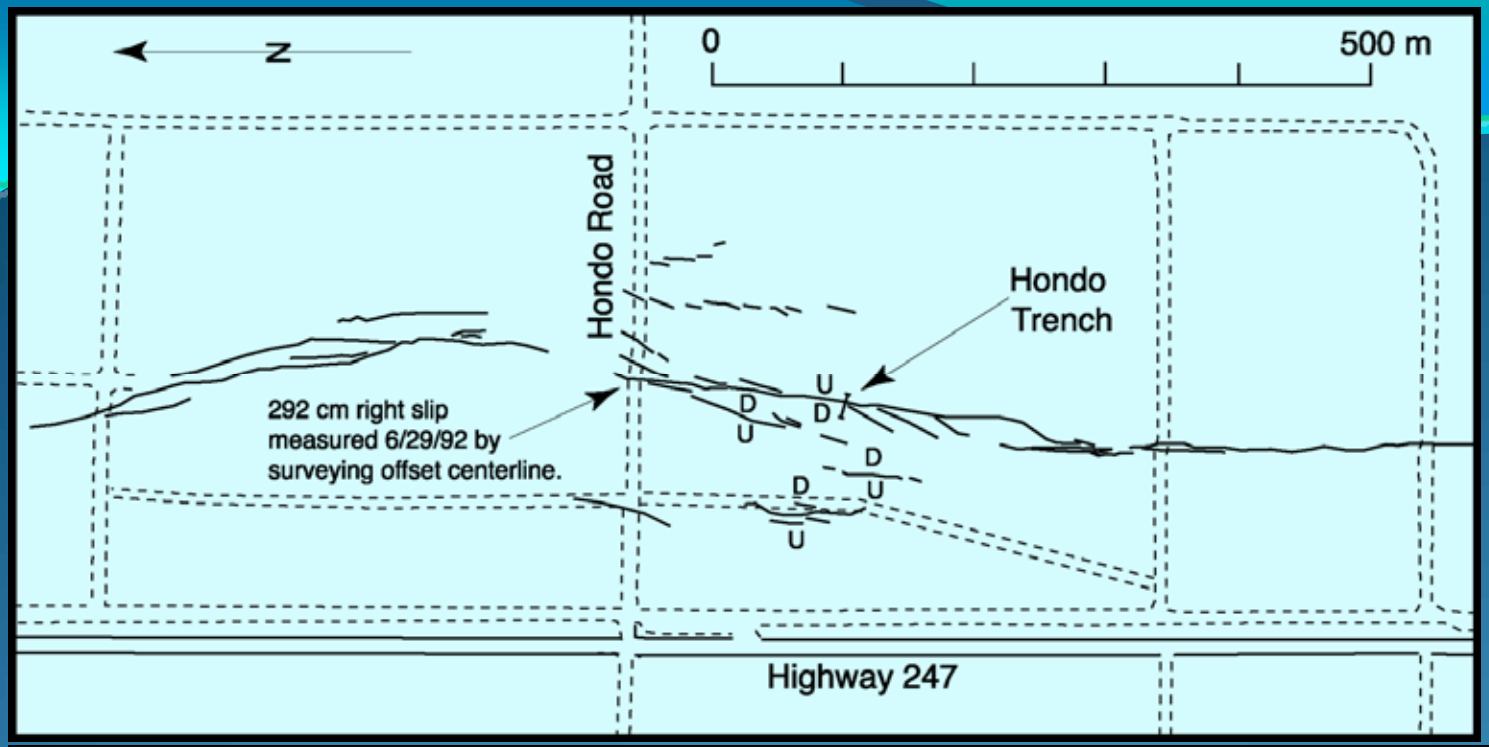
NAF – Rockwell et al., 2001



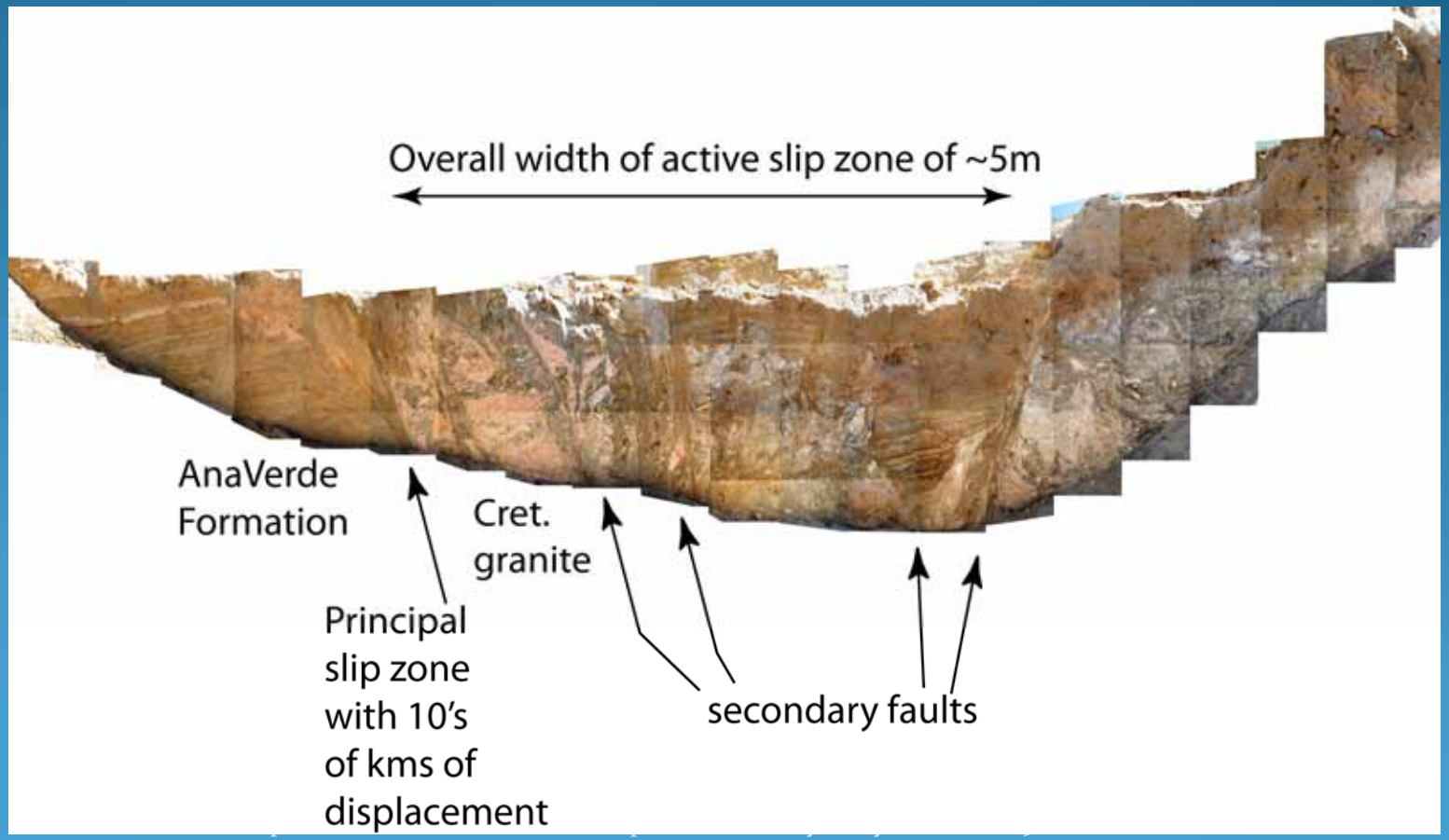
Rose Canyon Fault in San Diego – multiple active strands in late Quaternary, narrow rupture in MRE



1992 Landers Rupture

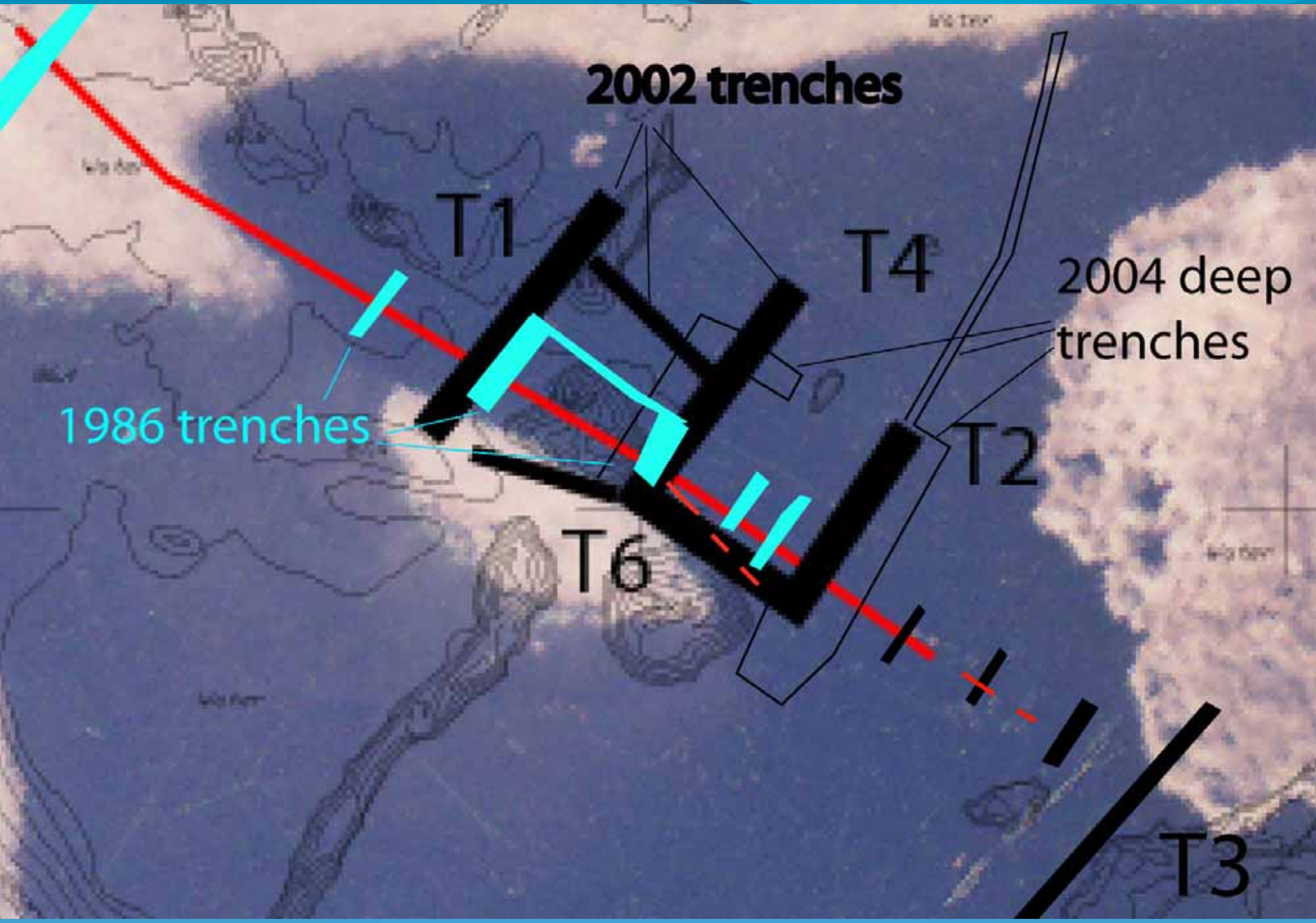


San Andreas Fault at Little Rock



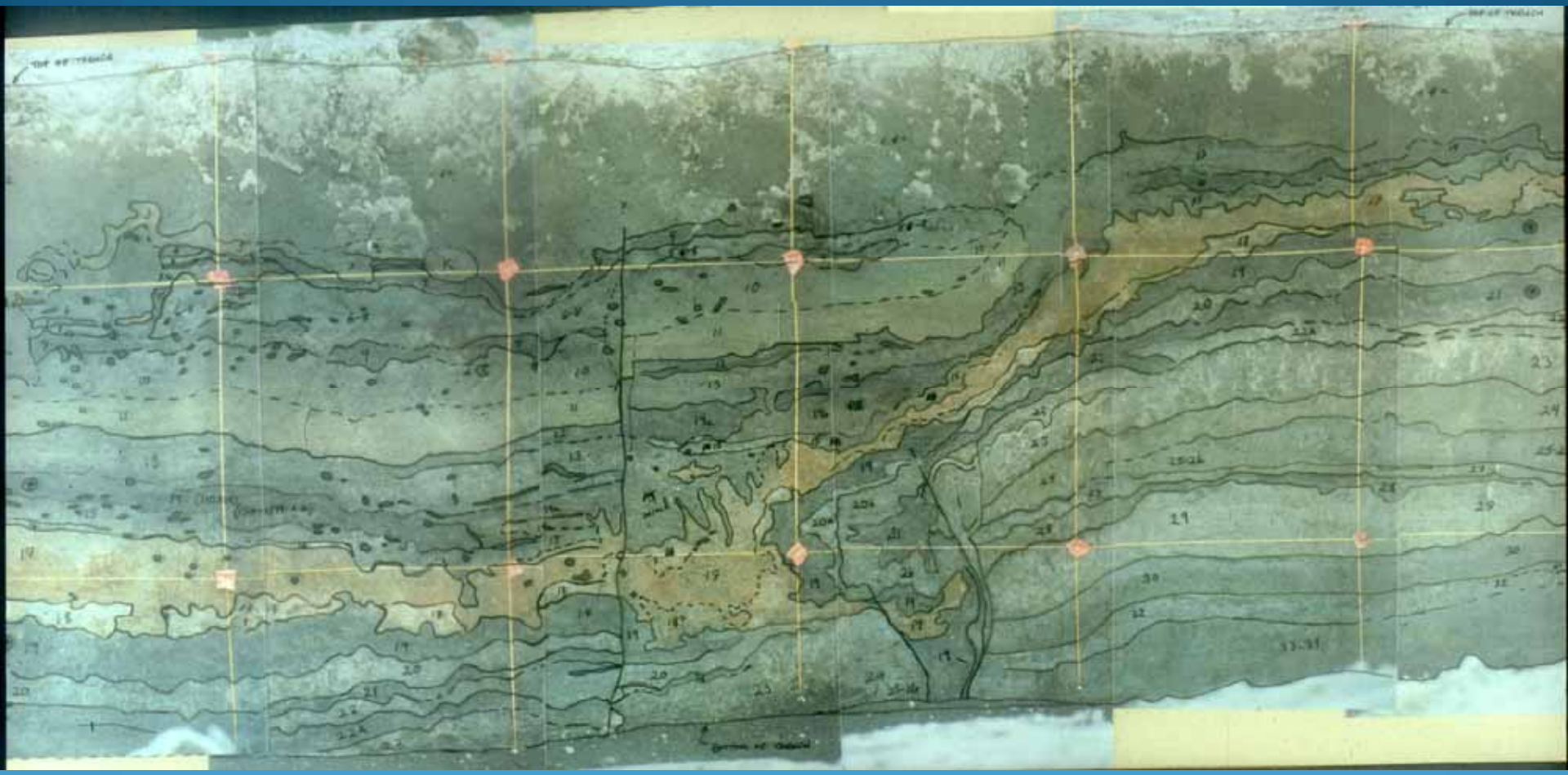
Where faults are relatively straight, the rupture zones tend to be quite narrow

San Jacinto Fault: Narrow active trace with ~15 mm/yr slip rate based on trenching of an offset channel

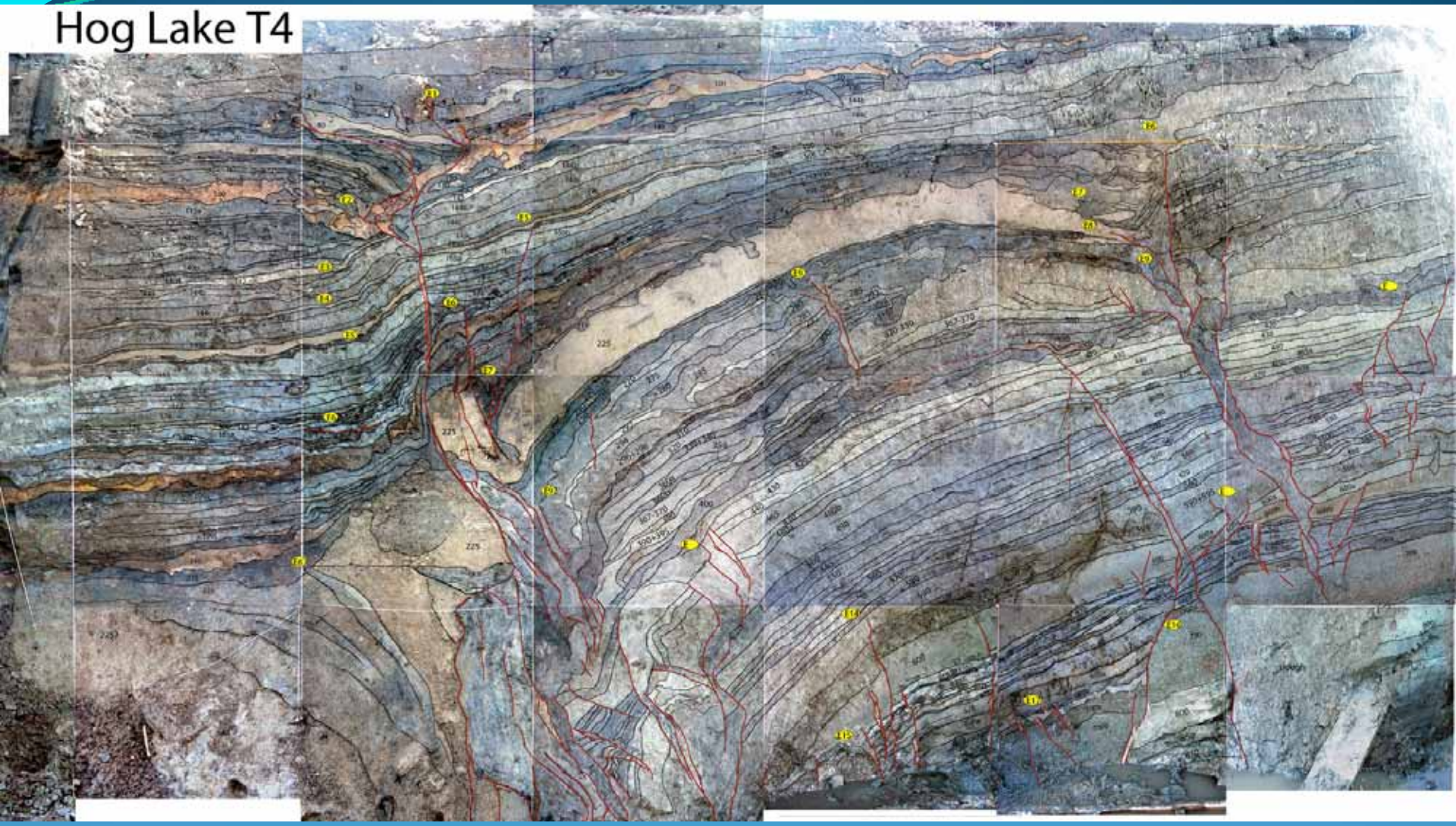

2002 trenches
T1
T4
2004 deep
trenches
1986 trenches
T2
T6
T3

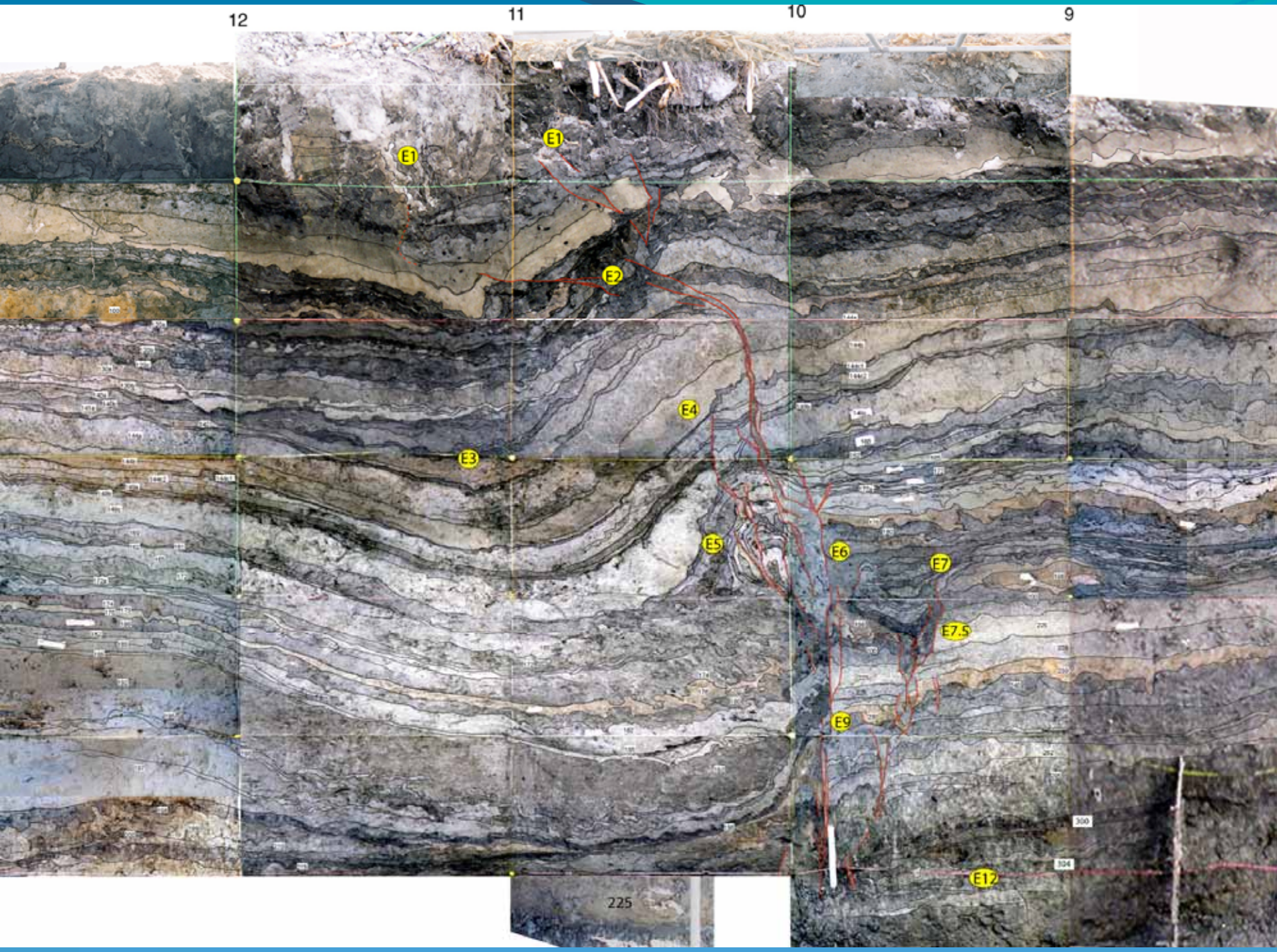

southeast
trenches
alluvial fan
San Jacinto fault

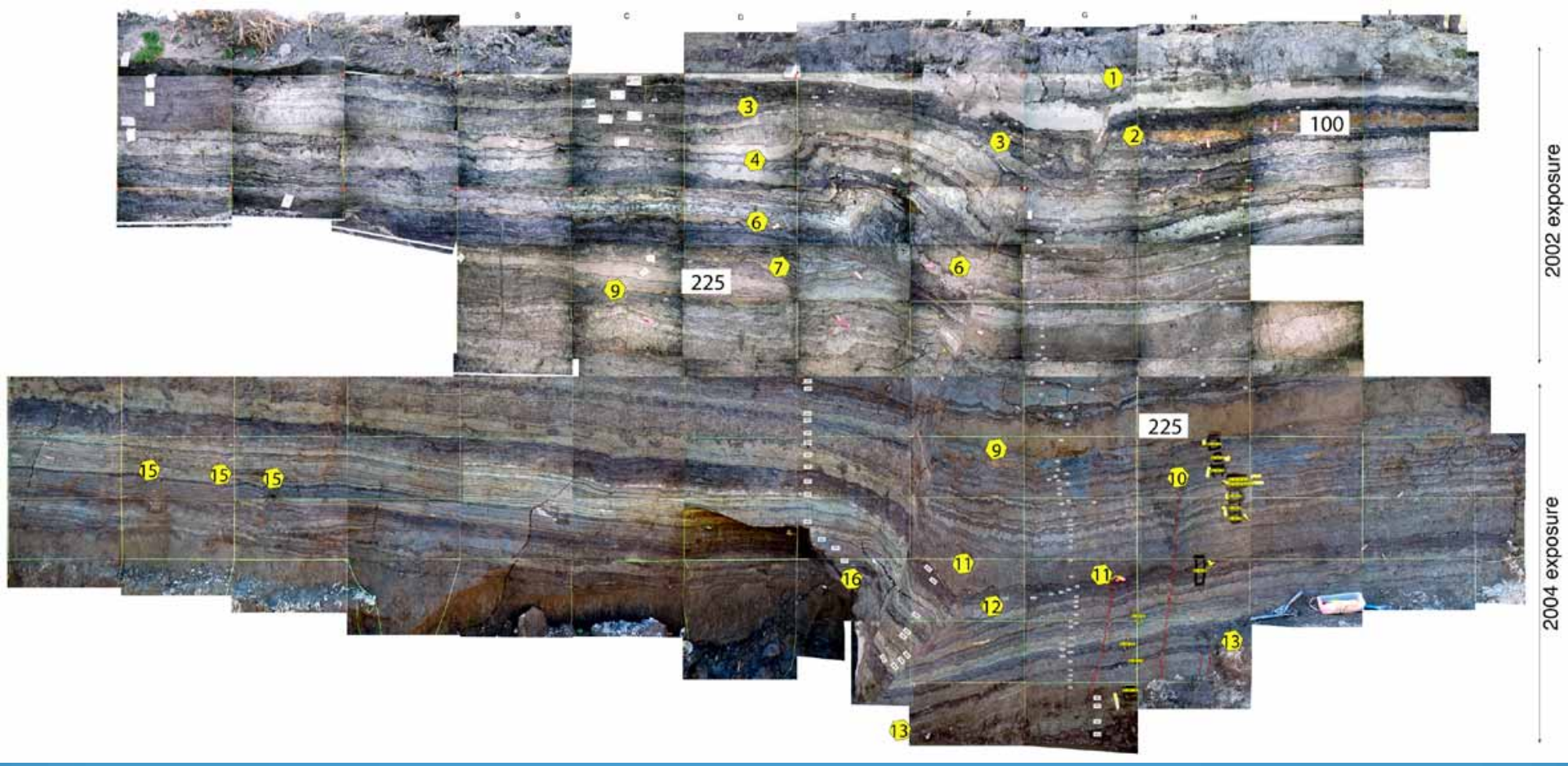
Rupture in individual earthquakes can be quite narrow



Hog Lake T4

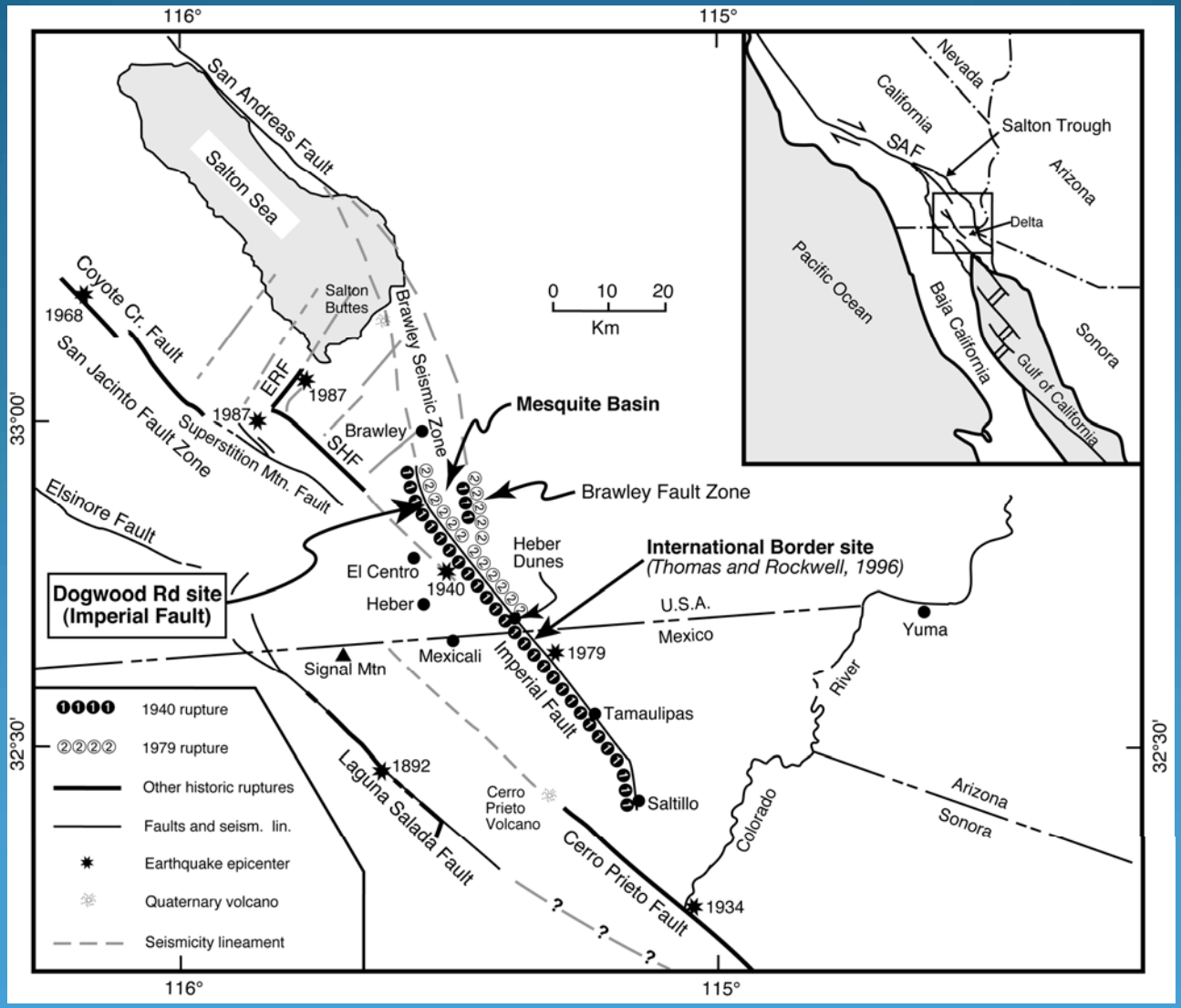



12
11
10
9
E1
E1
E2
E3
E4
E5
E6
E7
E7.5
E9
E12
225


100
225
225
2002 exposure
2004 exposure

The Imperial Fault, Southern California

Ruptures up through 6-10 km of sediment, with two historical ruptures (1940, 1979)

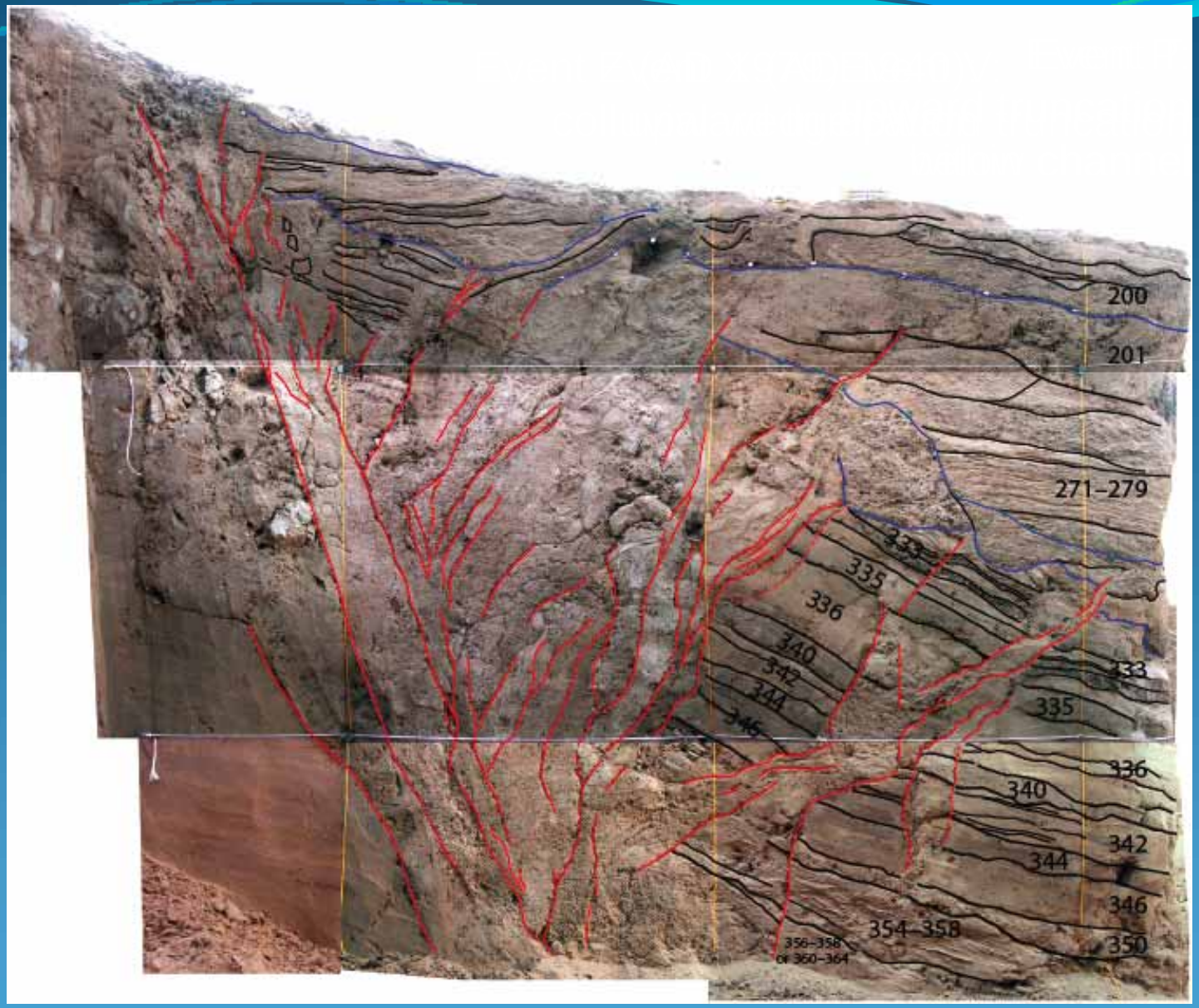


The Imperial Fault along Mesquite Basin

1 mile

1 km

SW T4 NW Wall NE



0 1 m

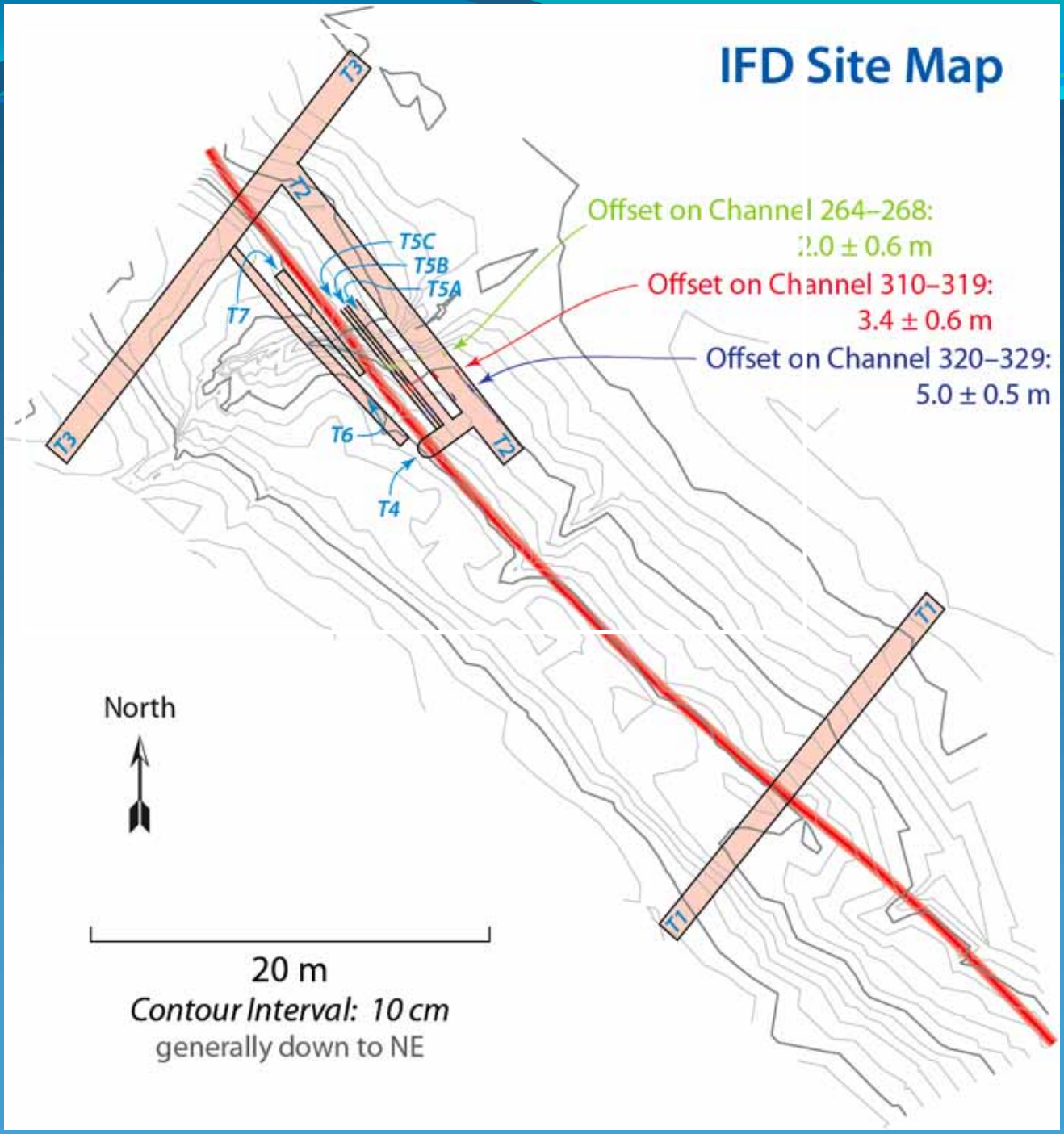
NE

SW

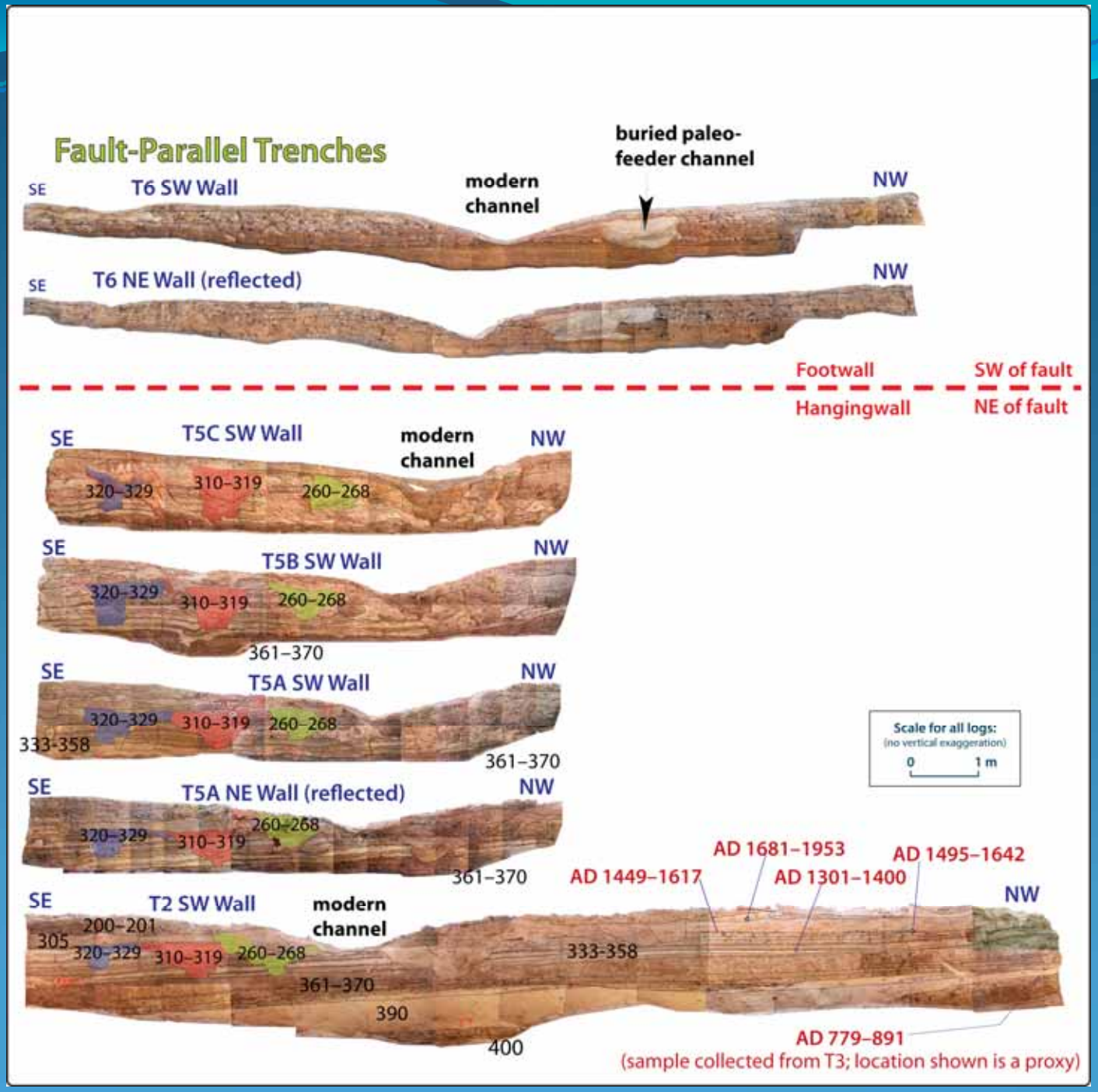
T4 SE Wall

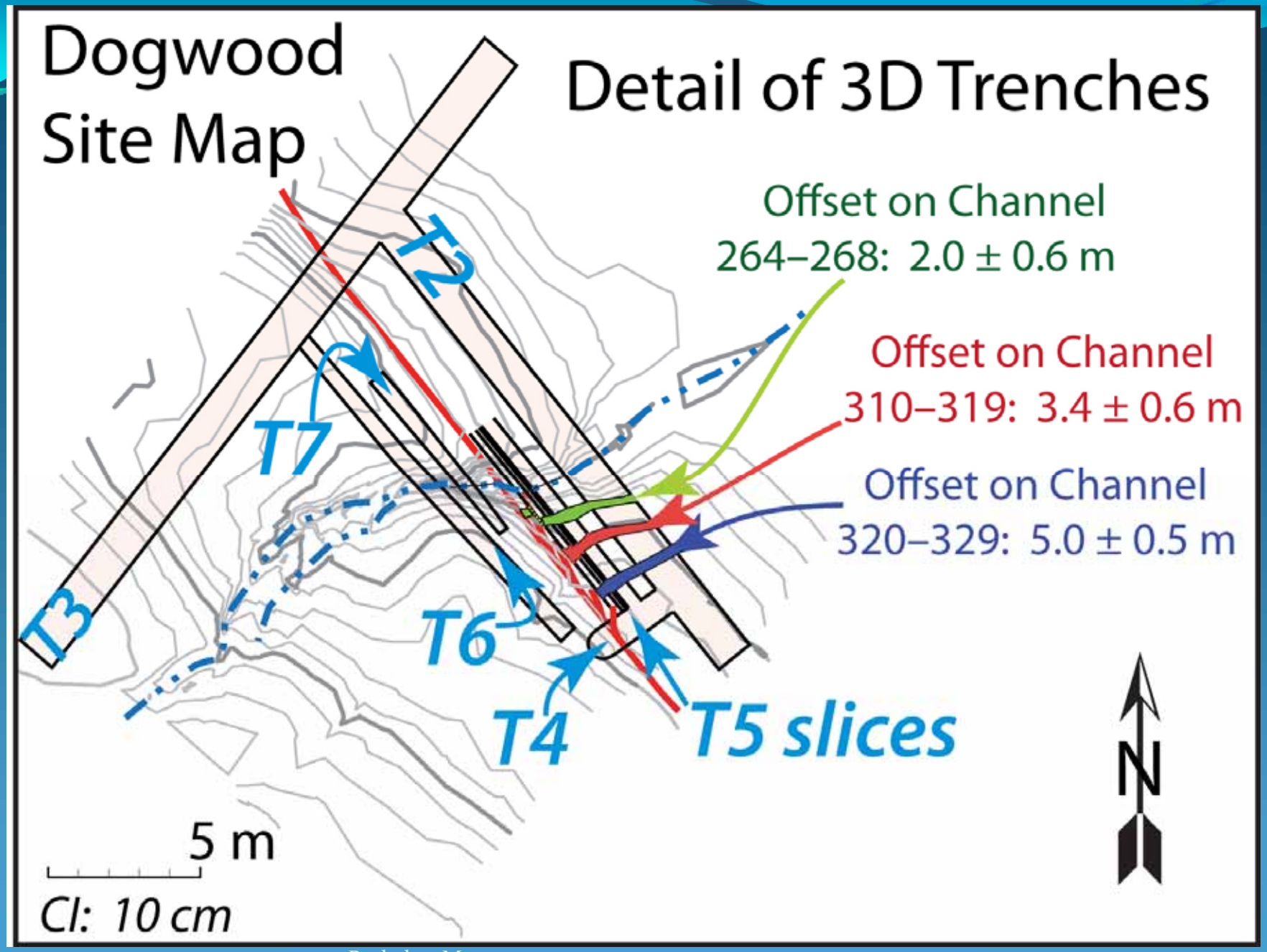
0

1 m


IFD Site Map
Offset on Channel 264–268:
2.0 ± 0.6 m
Offset on Channel 310–319:
3.4 ± 0.6 m
Offset on Channel 320–329:
5.0 ± 0.5 m
T3
T2
T5C
T5B
T5A
T7
T6
T4
T1
North
20 m
Contour Interval: 10 cm
generally down to NE


T6
T5
T6
T2
T5
T4
T4
T2
View to W


Fault-Parallel Trenches
buried paleo-
feeder channel
SE
T6 SW Wall
modern
channel
NW
SE
T6 NE Wall (reflected)
NW
Footwall
SW of fault
Hangingwall
NE of fault
SE
T5C SW Wall
modern
channel
NW
320–329
310–319
260–268
SE
T5B SW Wall
NW
320–329
310–319
260–268
361–370
SE
T5A SW Wall
NW
320–329
310–319
260–268
333-358
361–370
Scale for all logs:
(no vertical exaggeration)
0
1 m
SE
T5A NE Wall (reflected)
NW
260–268
320–329
310–319
361–370
AD 1681–1953
AD 1495–1642
AD 1449–1617
AD 1301–1400
SE
T2 SW Wall
modern
channel
NW
200–201
305
320–329
310–319
260–268
333-358
361–370
390
400
AD 779–891
(sample collected from T3; location shown is a proxy)


Dogwood
Site Map
Detail of 3D Trenches
Offset on Channel
264–268: 2.0 ± 0.6 m
Offset on Channel
310–319: 3.4 ± 0.6 m
Offset on Channel
320–329: 5.0 ± 0.5 m
T2
T7
T3
T6
T4
T5 slices
N
5 m
CI: 10 cm

Fault slip versus off-fault warping, slip gradients

A case study from the 1999 Izmit and Duzce earthquakes

Resolution of near-field and far-field deformation

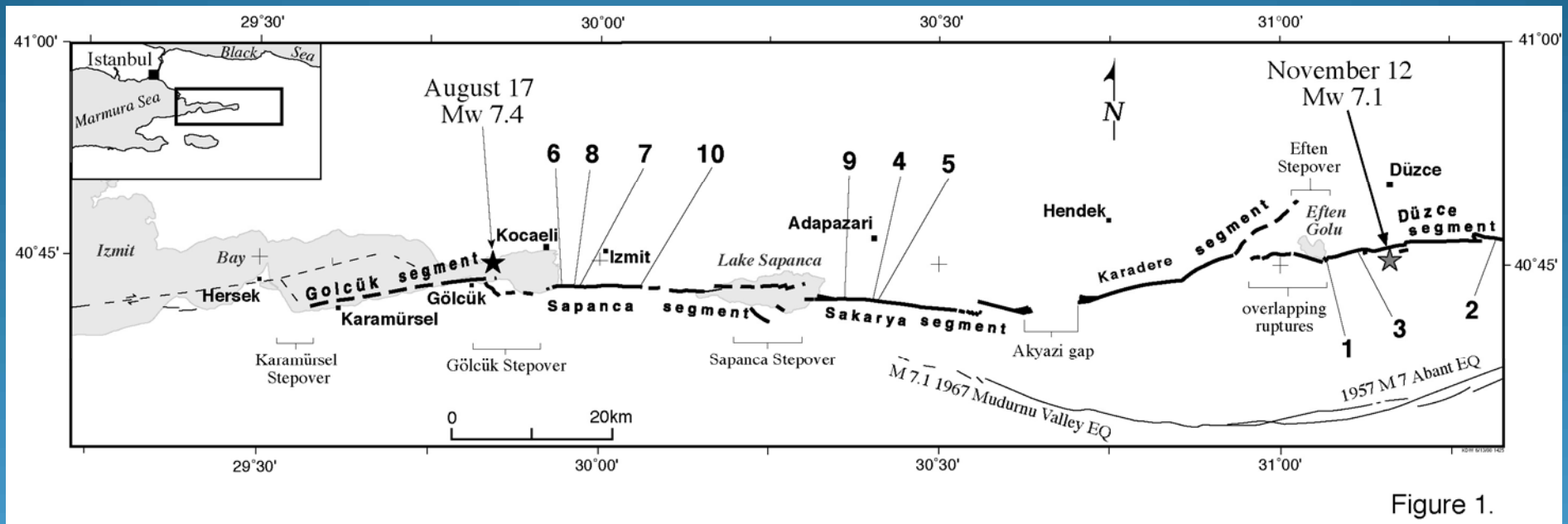


Figure 1.

Rockwell et al., 2002

Offset Kavak (poplar)tree grove near Sapanca, east of Izmit

Surveyed trees, fence posts, other cultural features across the fault

Definitions and measurement criteria

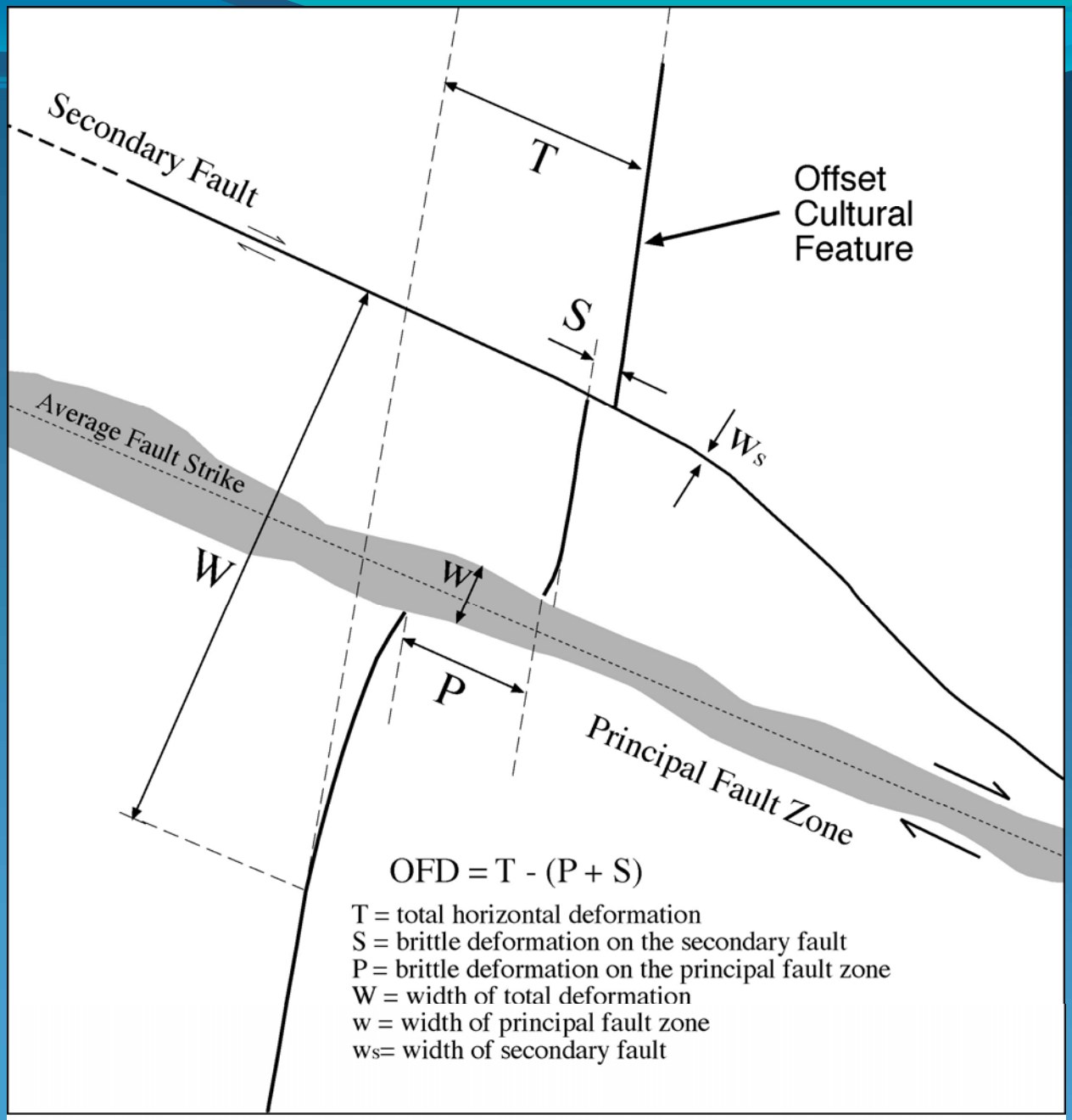


Fig. 3

Site 6. Offset concrete-lined flume

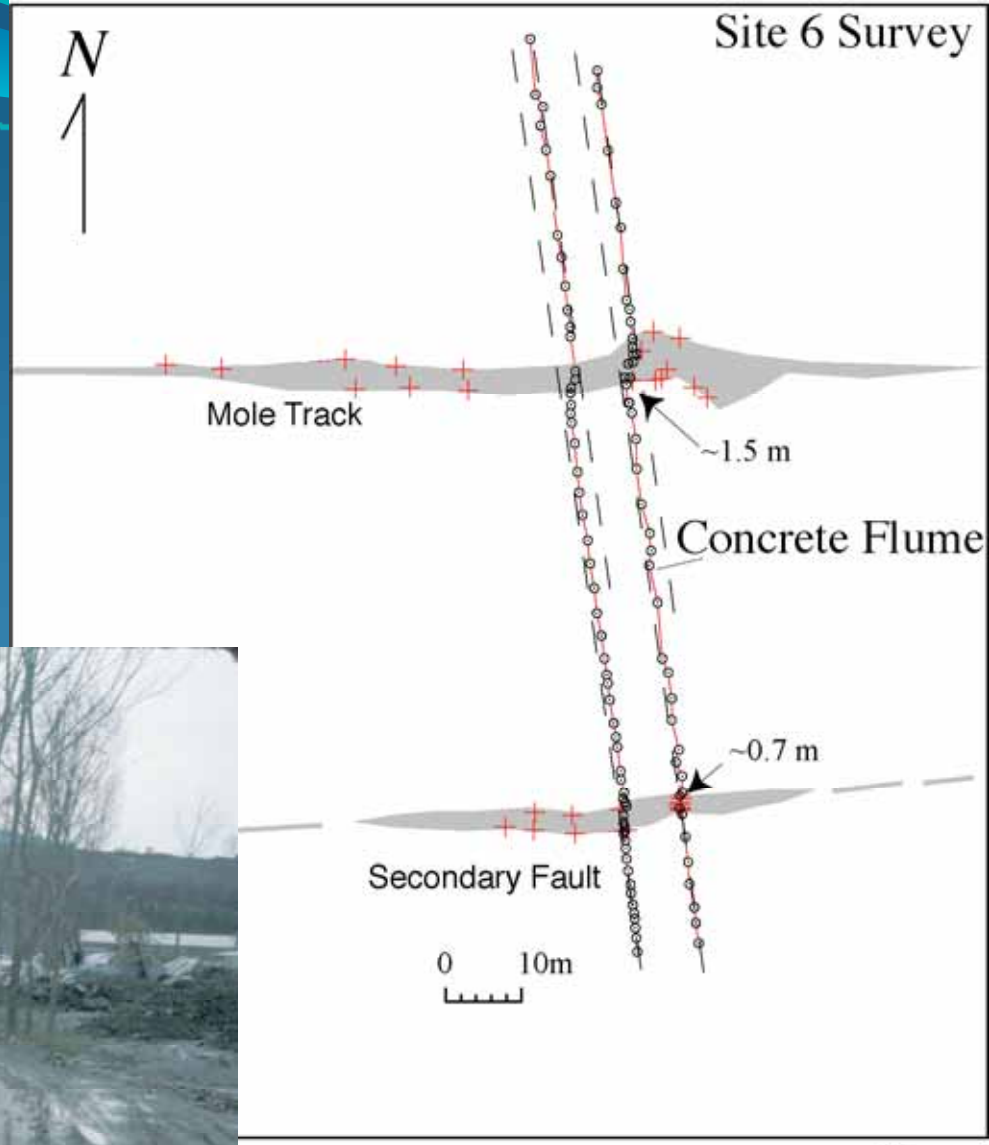


Figure 4

Site 8 - Offset fence

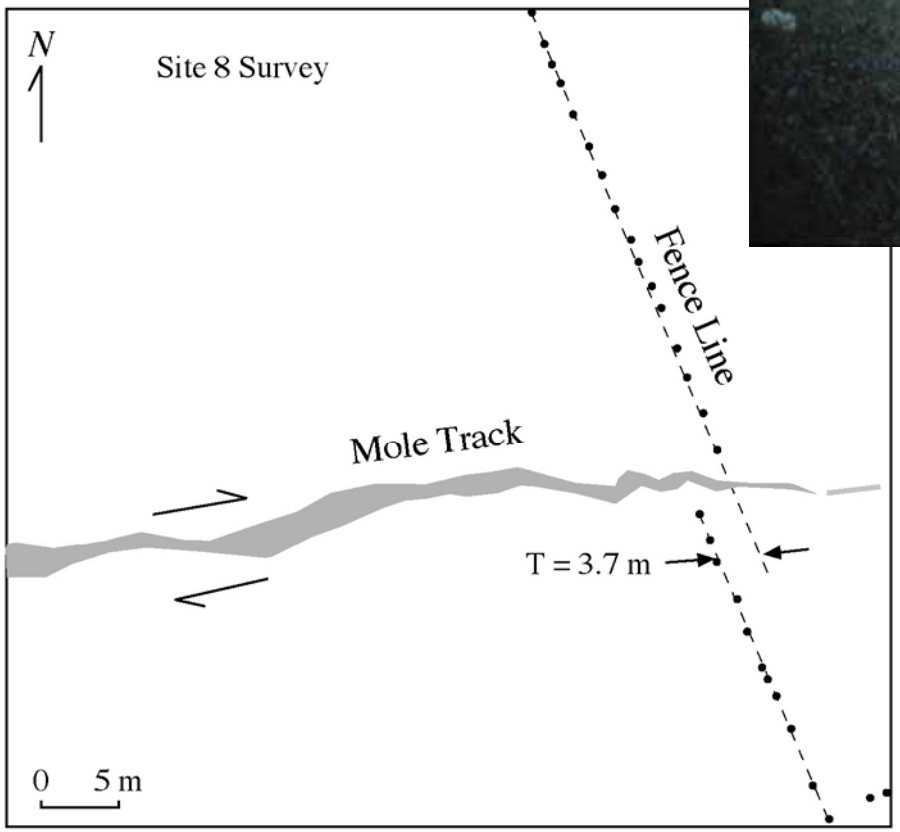


Figure 5.

Site 7 – Offset wall

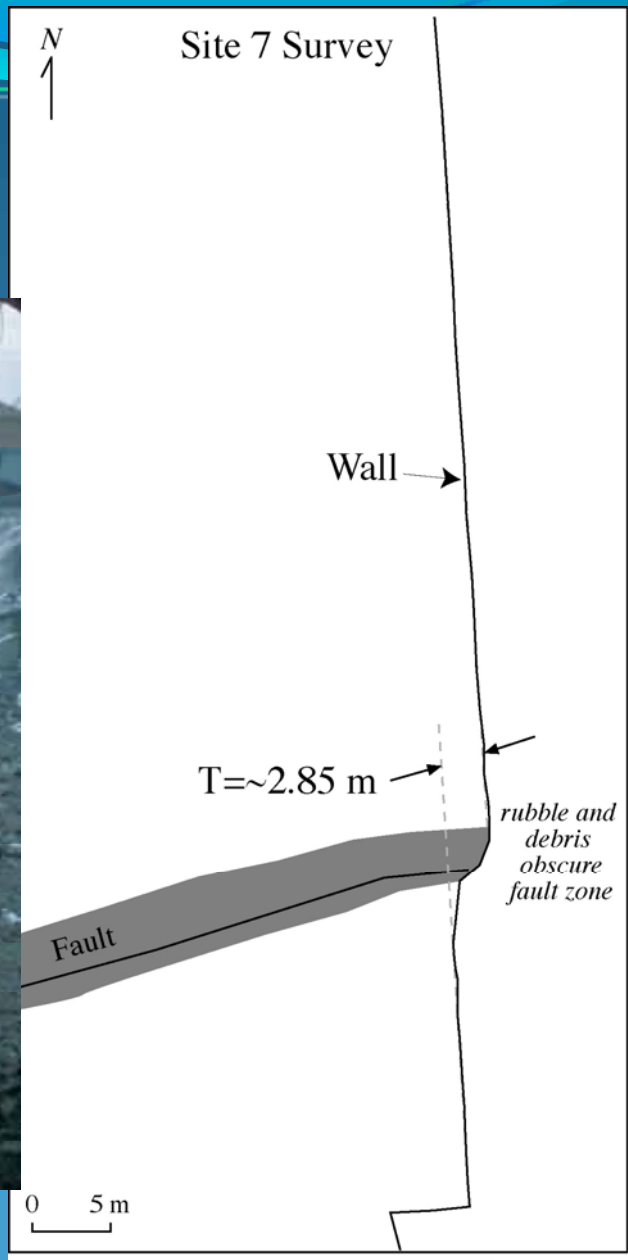


Figure 6

Site 10 – Offset stumps

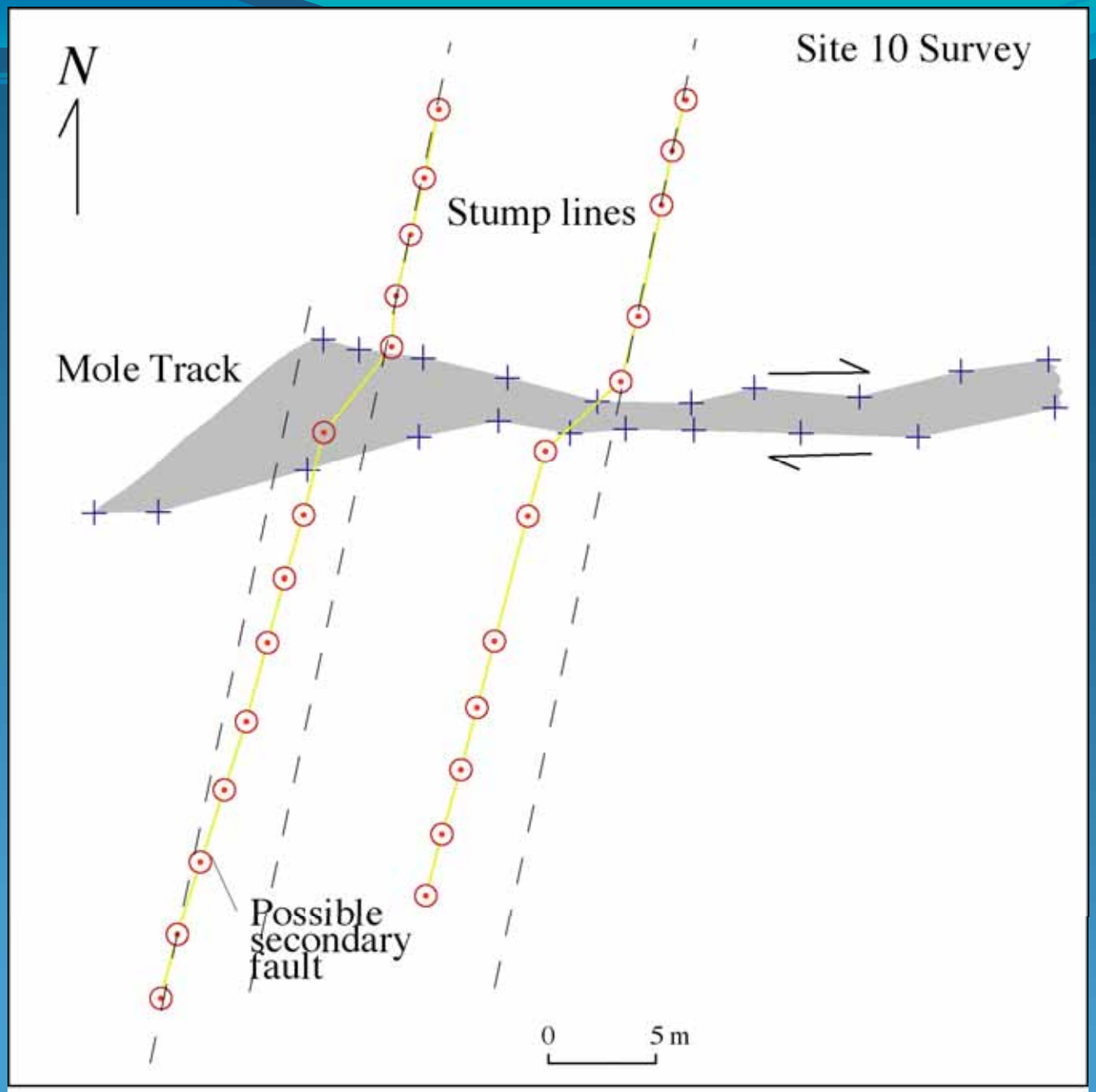
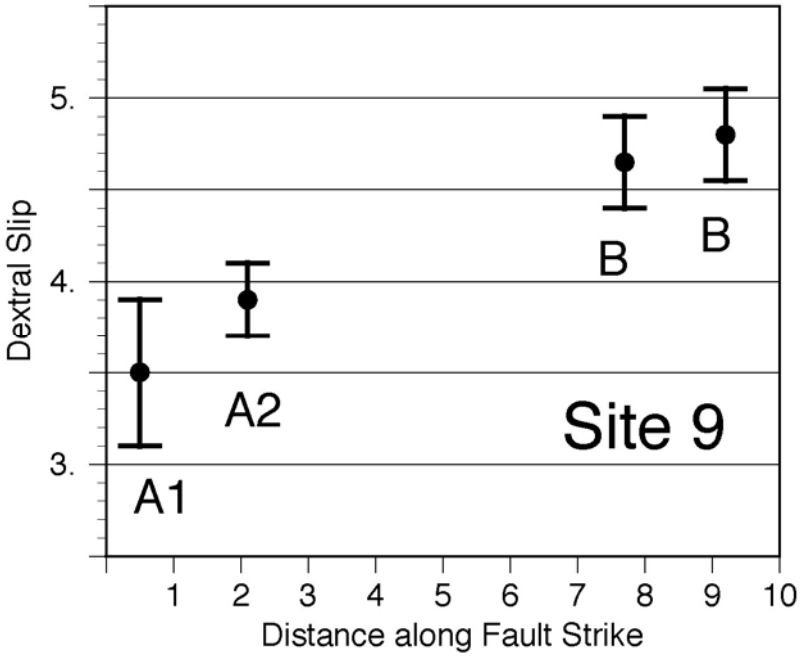
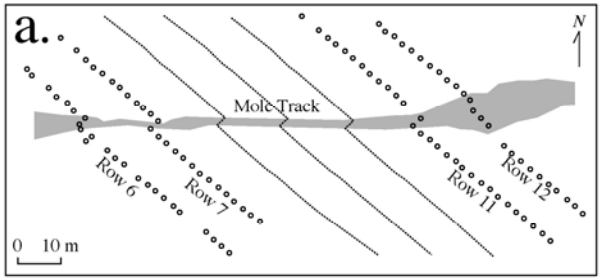
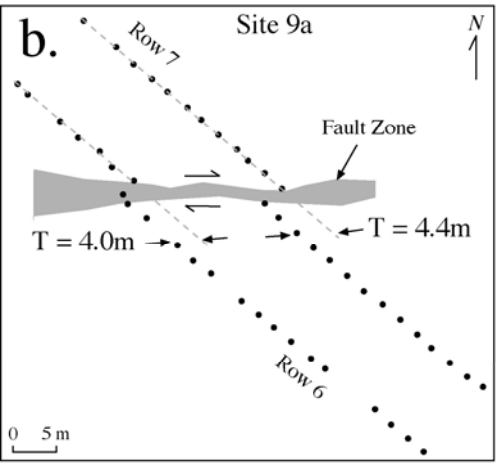


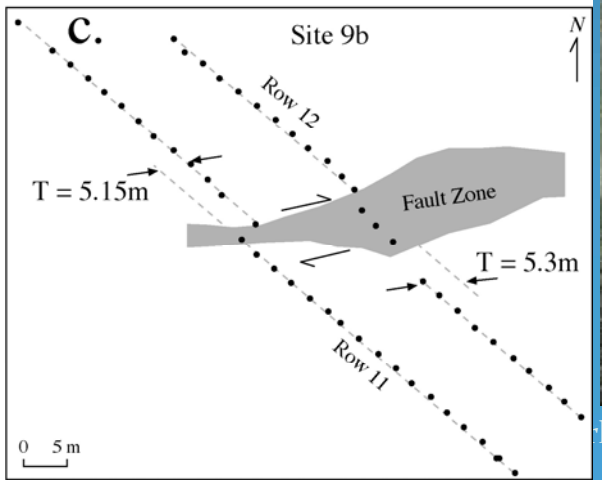
Figure 7



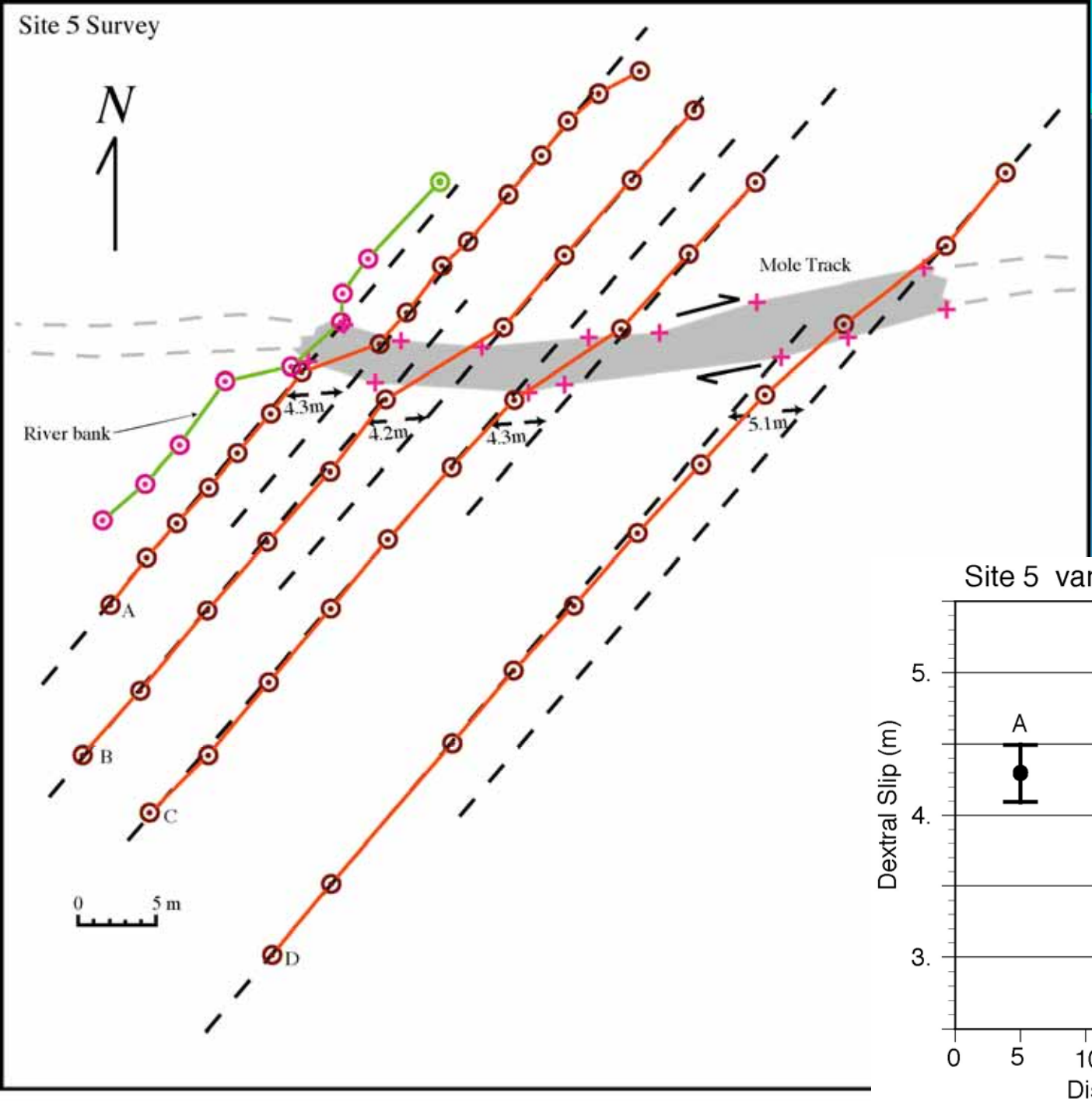
Site 9 – Offset trees

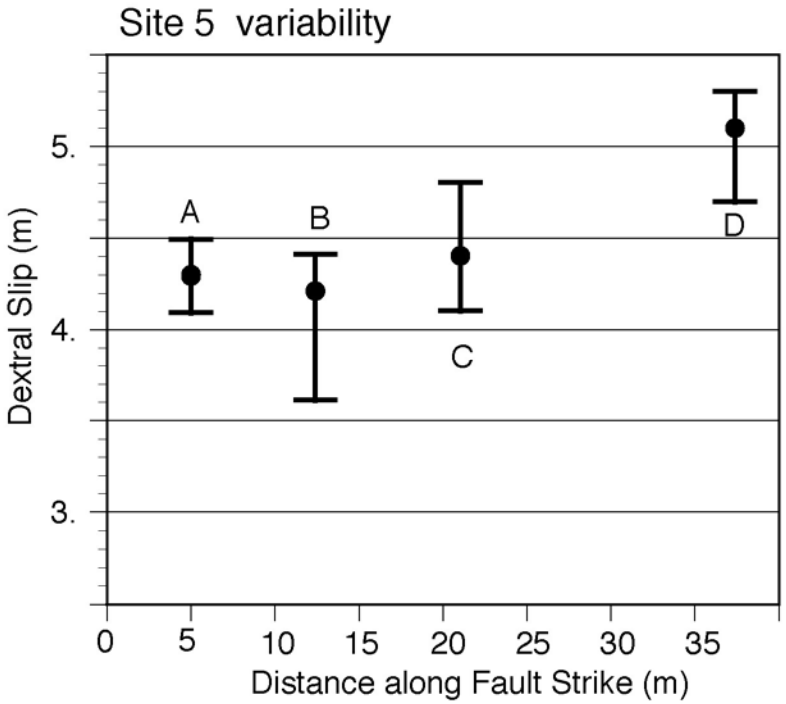




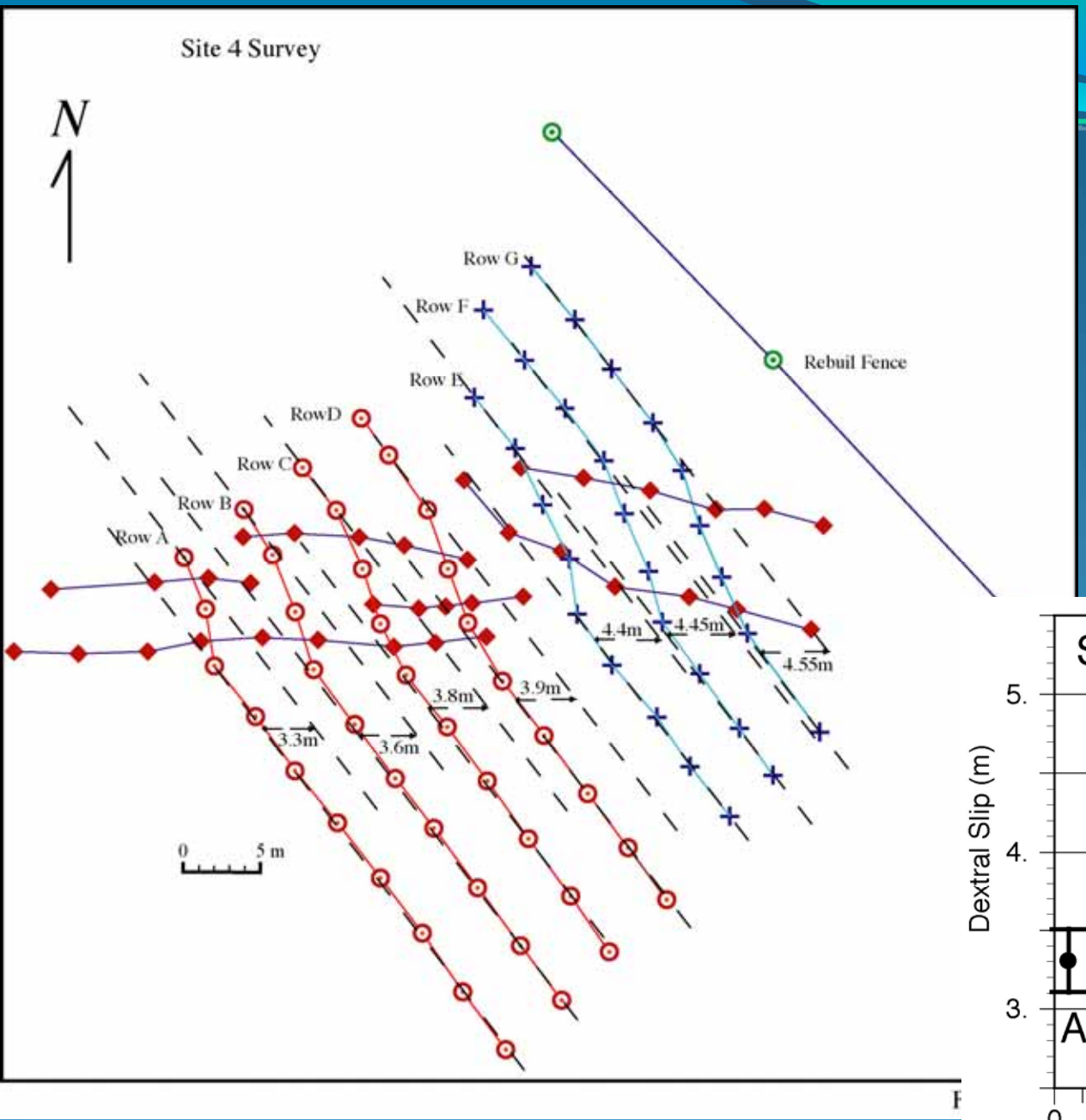


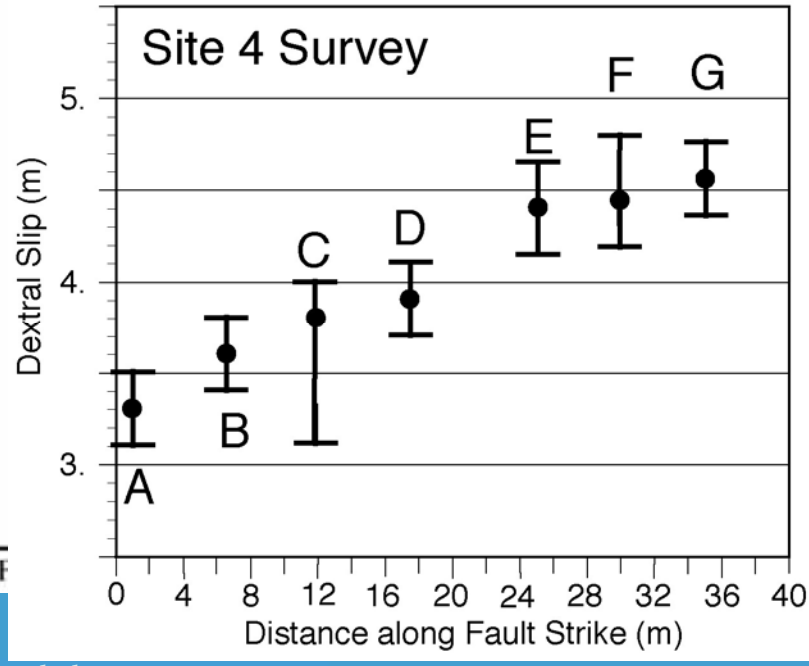
Site 5 – offset orchard

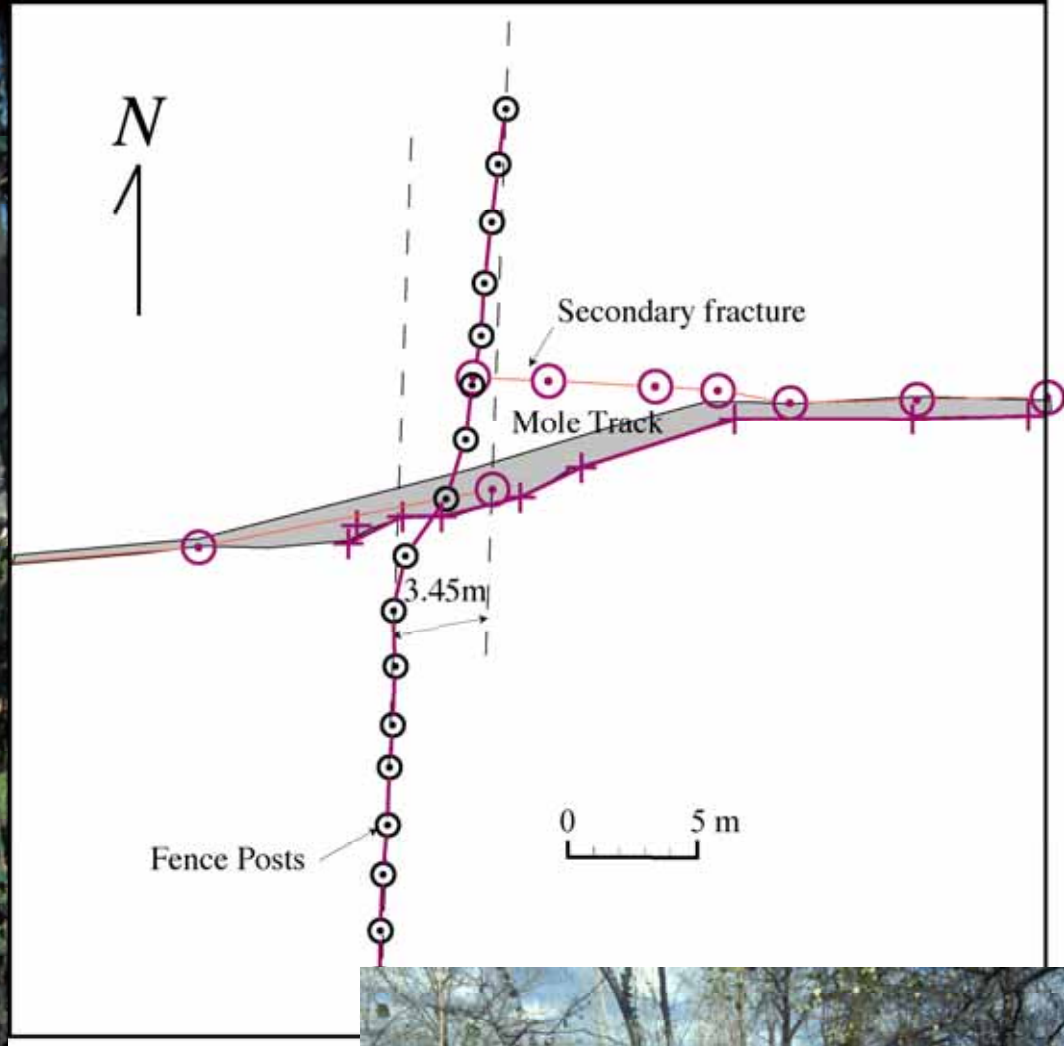




Site 4 – Offset tree grove

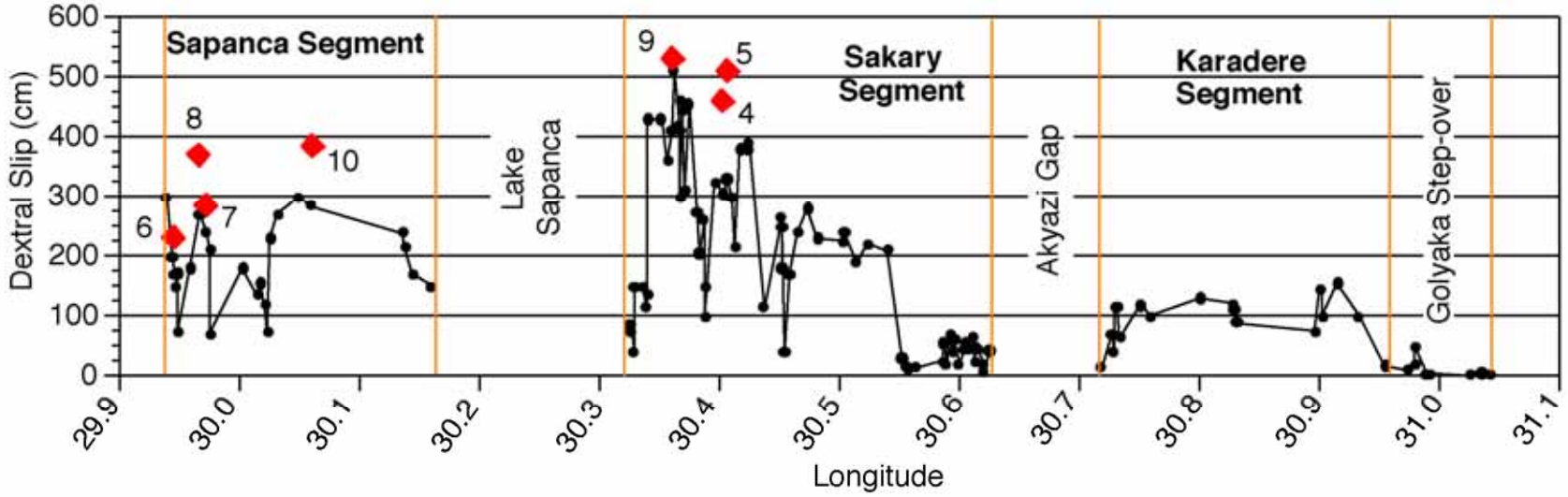


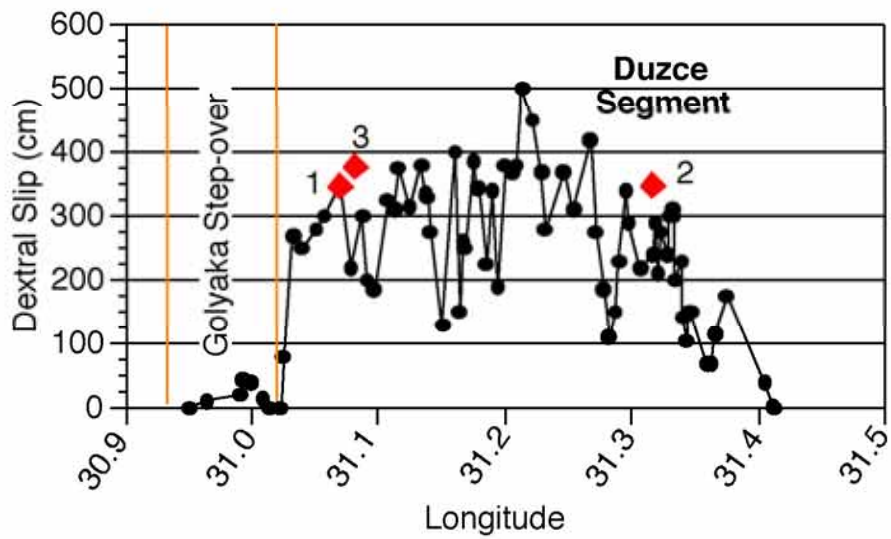




Site 2 – Offset fence line

Off-fault warping accounted for 0-40% of slip, and averaged about 15%, within a few meters of the fault, with nearly all on the side of thick alluvium





Lessons Learned

Straight portions of strike-slip faults tend towards highly localized slip, with most of the displacement in a narrow zone.

The width of faulting narrows with depth for individual ruptures (or, most ruptures splay to the surface)

Warping in near surface sediments is common, especially where alluvium is thick, and there are substantial along-fault slip gradients