3. Landforms related to different types of movements

Change in landscape implies change in landscape process

Look for **morphological anomalies** – surfaces warped, tilted, uplifted, fractured

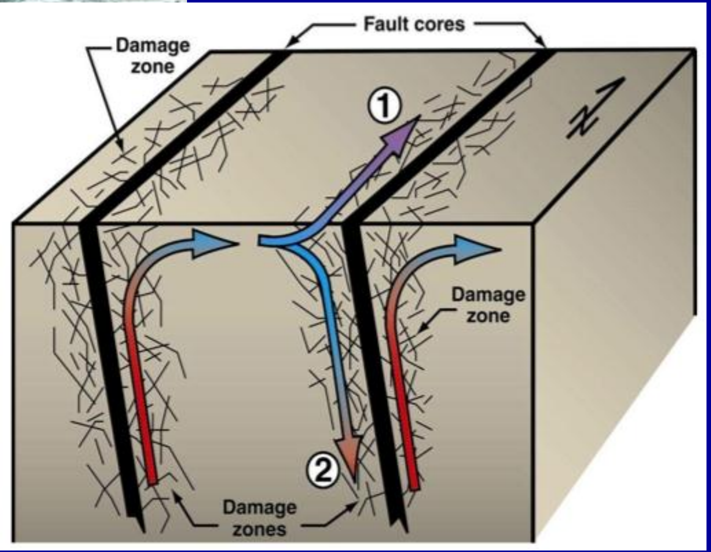
Some features indicate the presence of a fault, but say little about activity or type of movements

Vegetation alignments, springs, fault scarps, other lineaments

All Fault Types Have Potential to Disrupt Groundwater Flow/Create Scarps

- Springs – fault gouge (tektonický jíl) can be effective barrier

Gilman Hot Springs, San Jacinto Valley



- Vegetation Lineaments (arid areas)

San Andreas Fault - Thousand Palms Oasis, Indio Hills, California

Scarps – all fault types, all scales

Northward across Coyote Creek Fault, San Jacinto Fault Zone

Scarp on Strike-Slip (oblique slip)

A young scarp!! TINY!

Carboneras fault, Spain

Coyote Mts, Elsinore fault, CA

Scarps on normal fault

Krupnik fault , Bulgary, 1904 M=7,8

Scarps on thrust fault

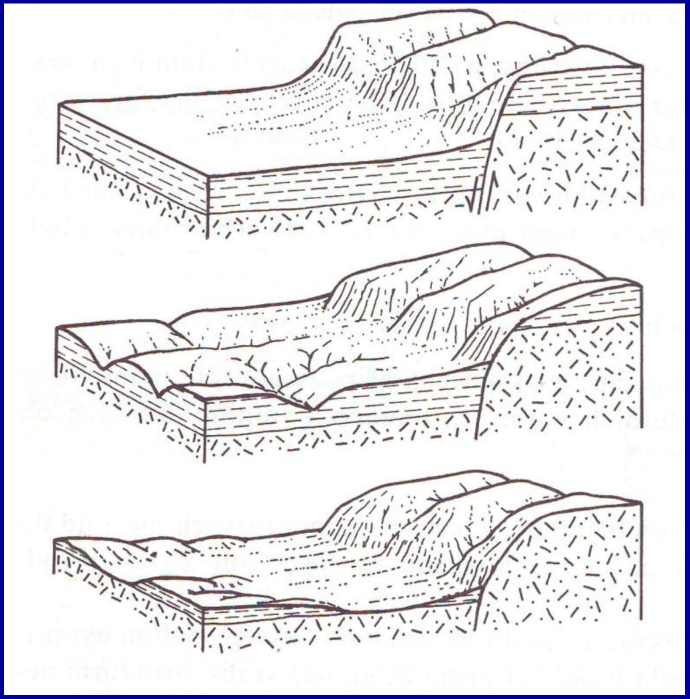
Chichi earthquake 1999, Taiwan

Active or Inactive? Don't be fooled

- Differential weathering along inactive faults can produce features that resemble features produced by active faults
  - Vegetation lineaments,
  - Linear valleys
  - Scarps
    - Known as

"**Fault-Line Scarps**"

(svah na zlomové čáře)



Sometimes these features exist, but they are not associated with any active faulting!! (differential erosion)

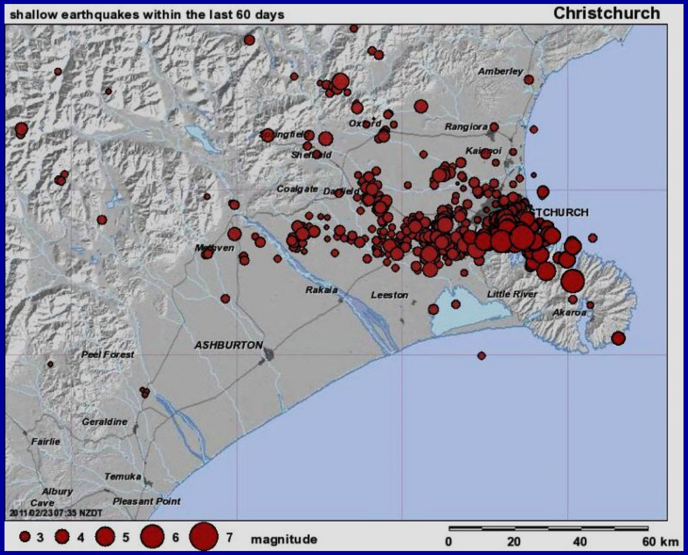
Some geomorphic features clearly indicate **young activity** (usually Holocene to late Quaternary)

- If it is expressed in the geomorphology, it is likely active (unless you can demonstrate that the features are totally erosional in nature)
  - scarps in alluvium, deflected drainages, sags, shutter ridges, side-hill benches

A general rule is that active faults produce alluvium so they bury themselves, so locally, the evidence for activity may be obscured along some portions of the fault

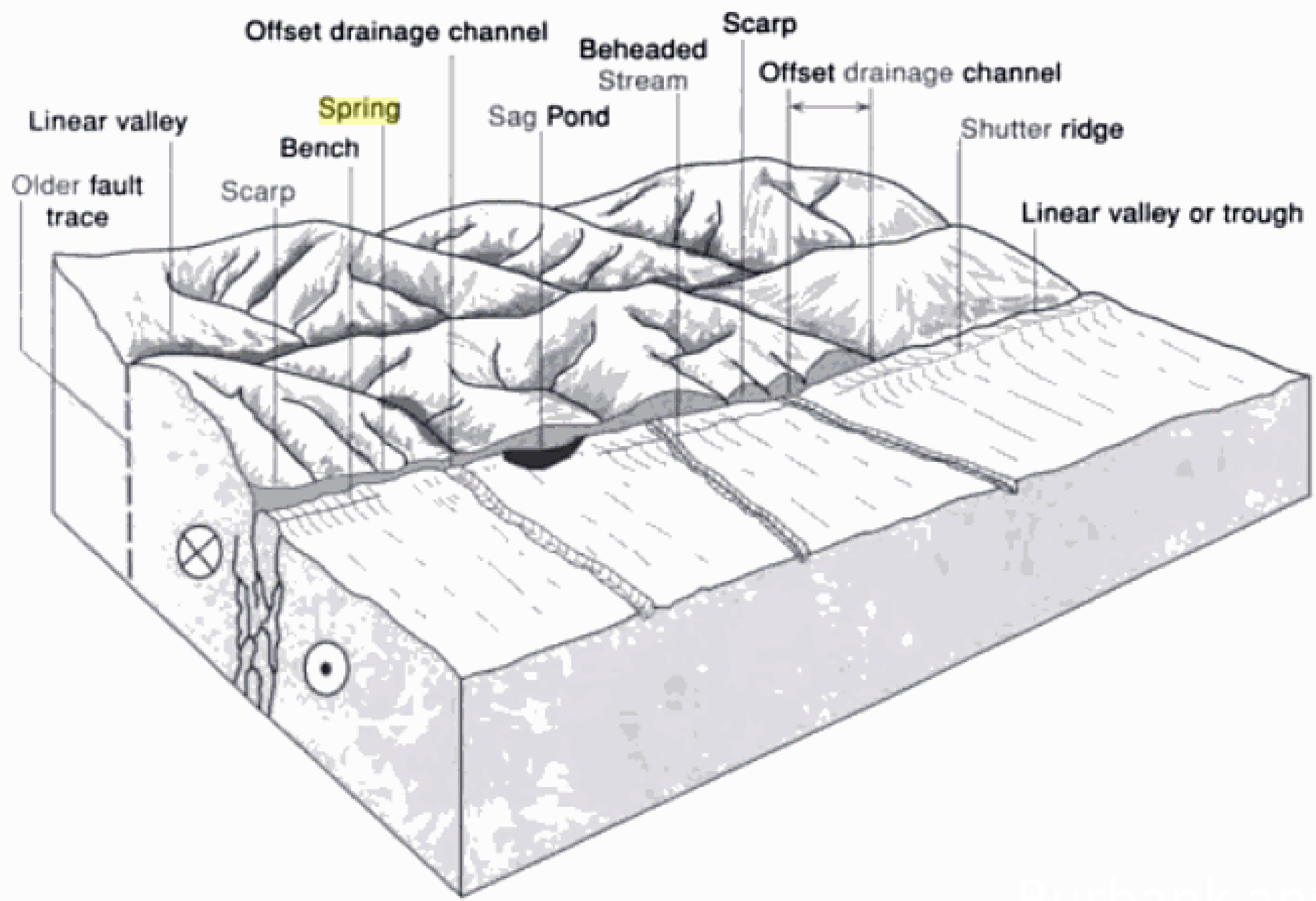
Christchurch EQ 21.2. 2011, M = 6.3, NZ

- **unknown fault,** uplift of Southern Alps – 10mm/year =high sedimentation, sediments obscure the fault trace



Active Strike-Slip Fault Geomorphology

FIGURE 4.18. Overview of strike-slip geomorphology



A linear trough along fault, sag ponds, shutter ridges, offset ridges and drainages, springs, scarps, and beheaded streams are typical geomorphic features indicative of strike-slip faulting. The older, abandoned fault trace displays analogous, but more erosionally degraded features. Modified after Wesson et al. (1975).

Effects on Stream Channels

Offsets

- Implies a previously straight, now-curved channel as a result of displacement
- the bend in the channel must agree with the sense of slip!

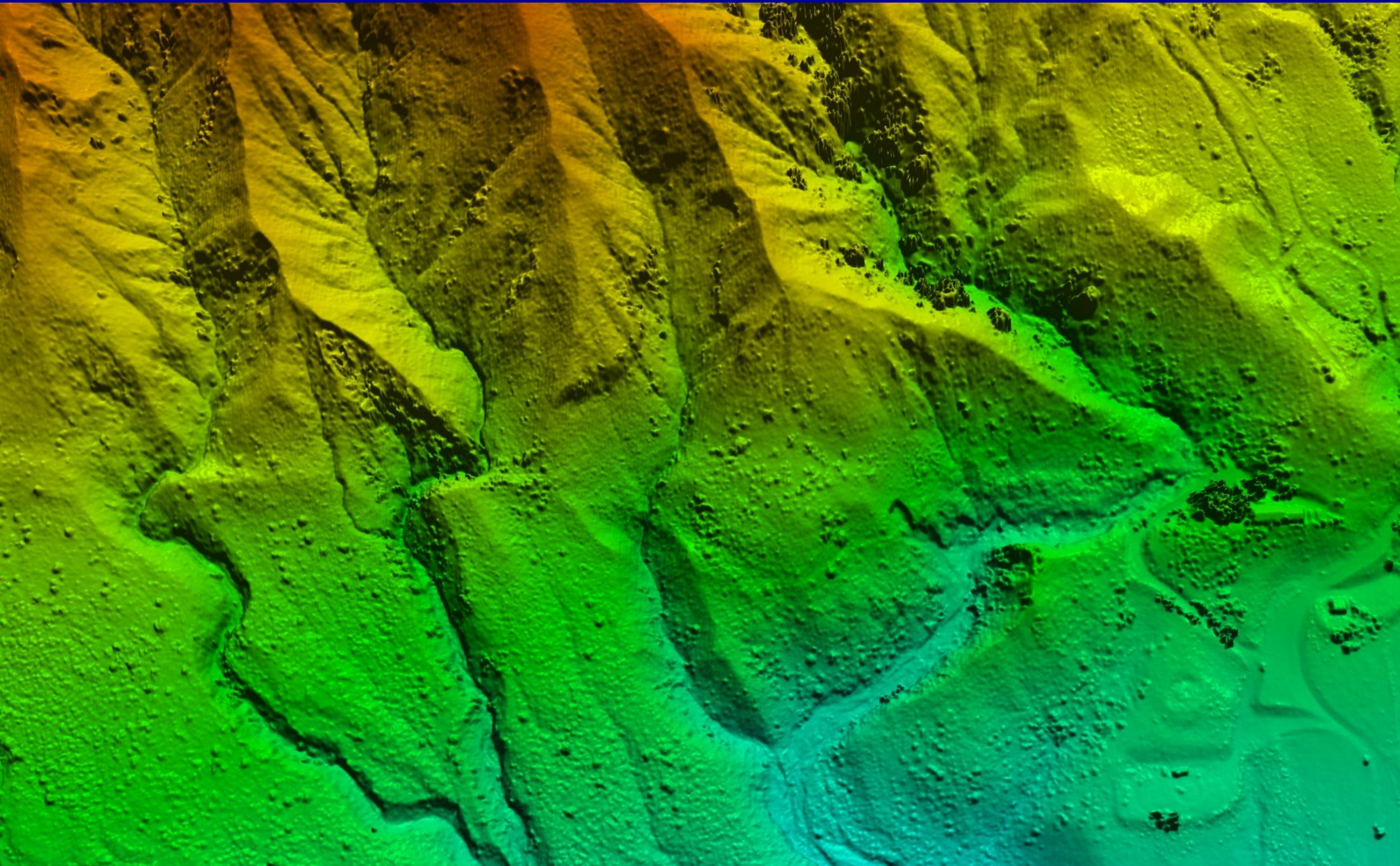
Deflections

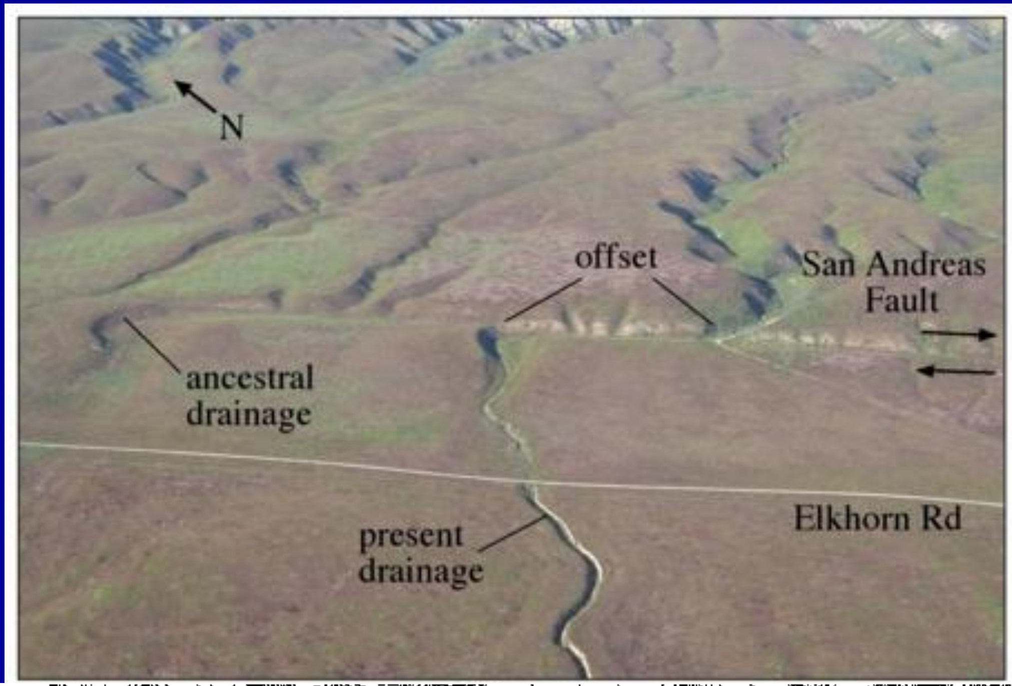
- The curve in the channel can be with or against the sense of slip
- Result of drainage capture
  - (water will take the easiest path downhill, alluvial fans)

All offsets are deflections, but not all deflections are offsets!

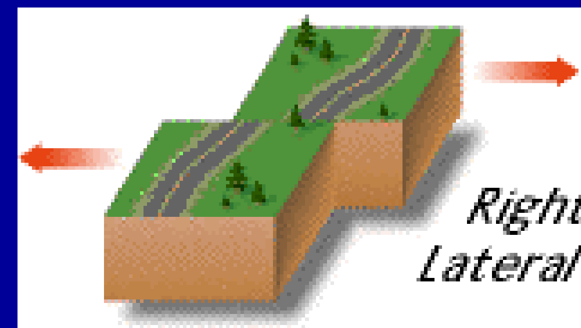
Offset channels

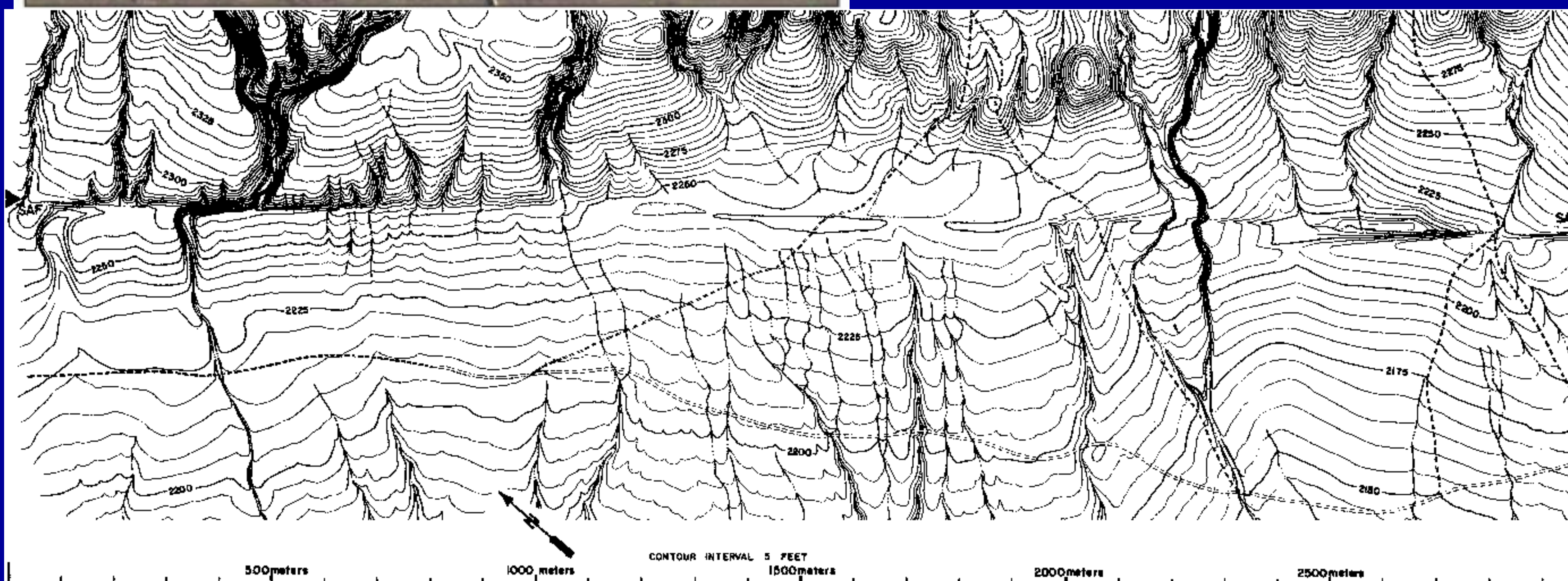
Pitman Canyon ~ 46 - meter offsets



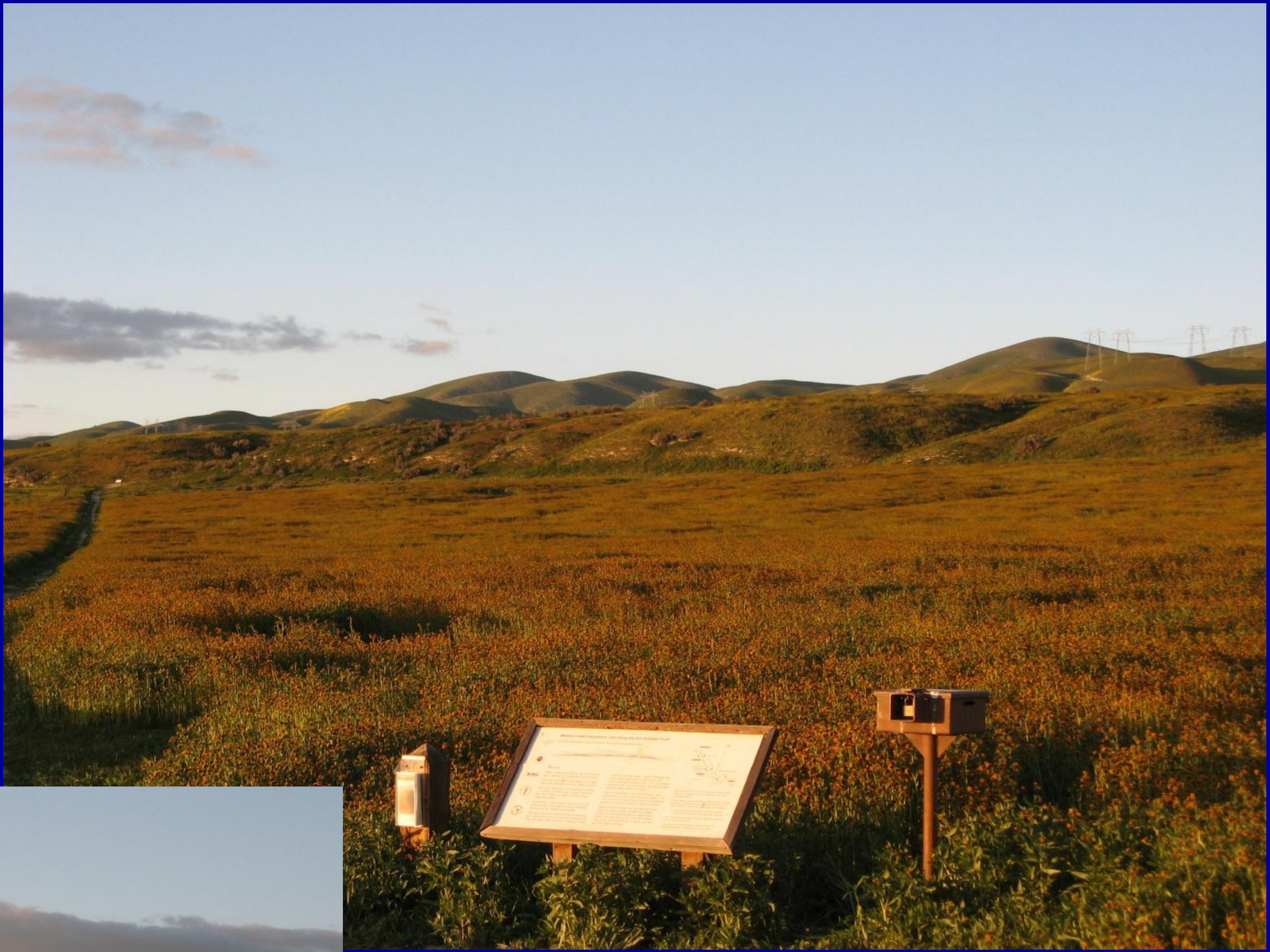


San Andreas Fault,
Carrizo plain, CA





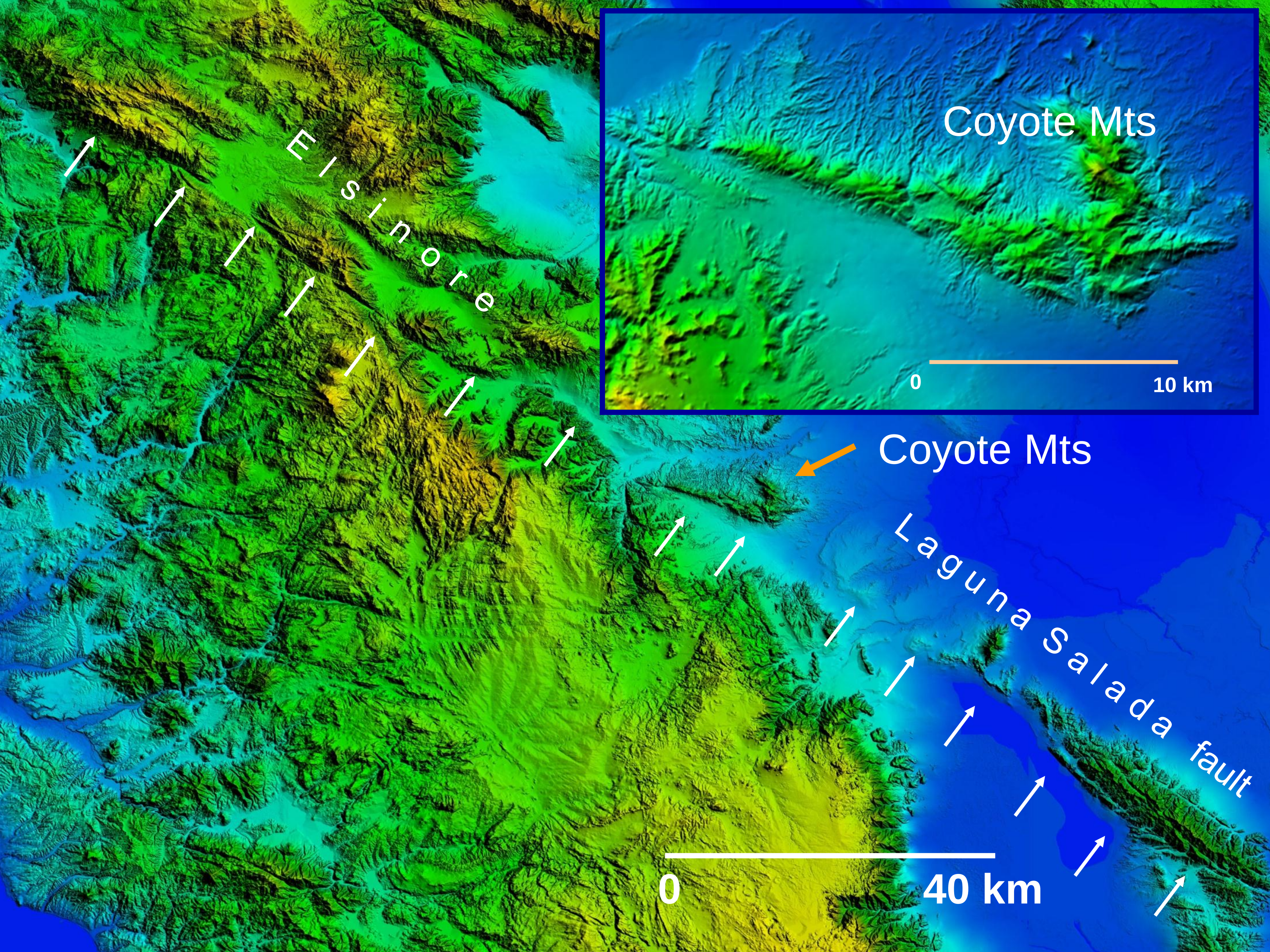
Wallace creek

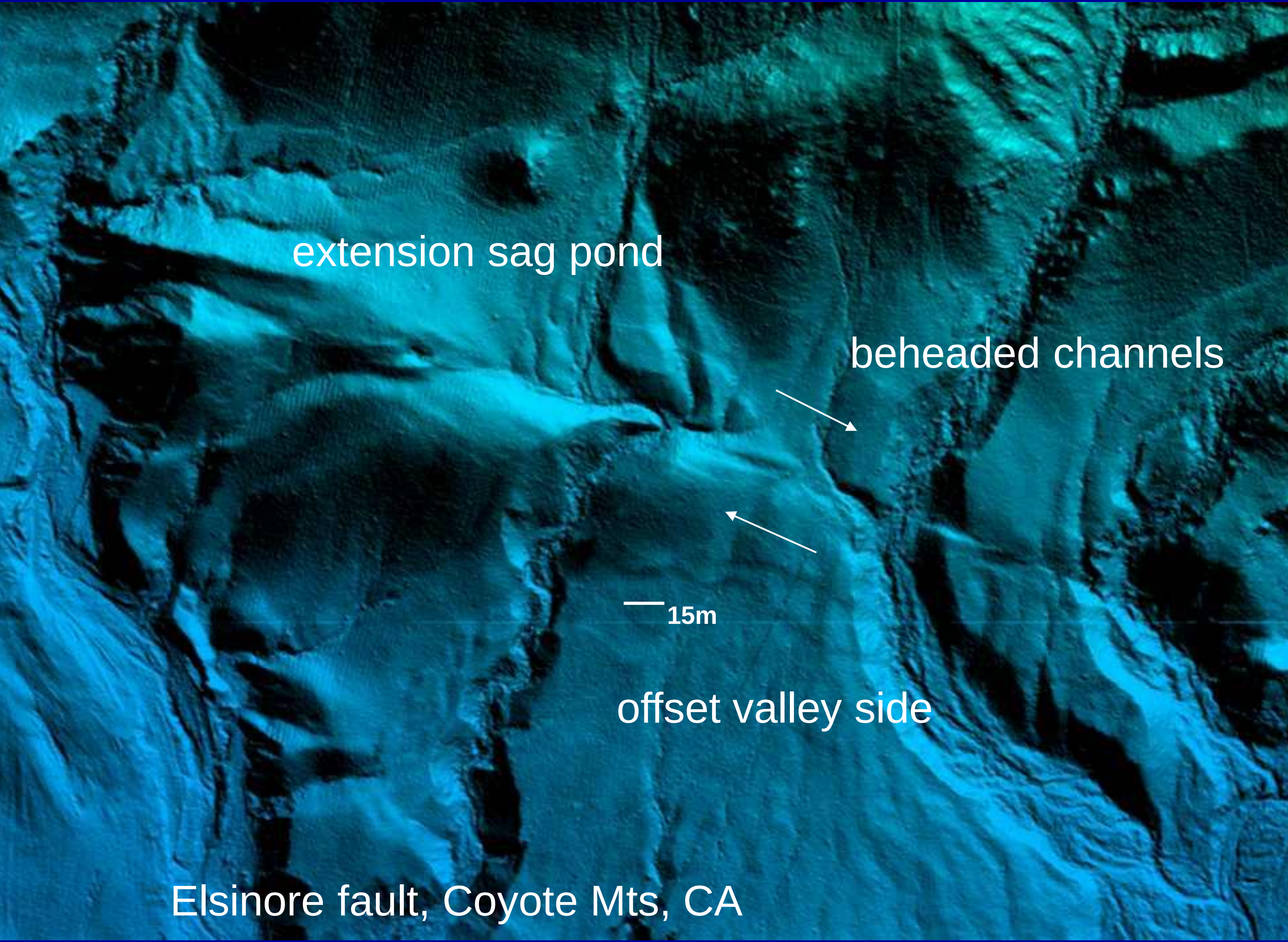


Wallace creek

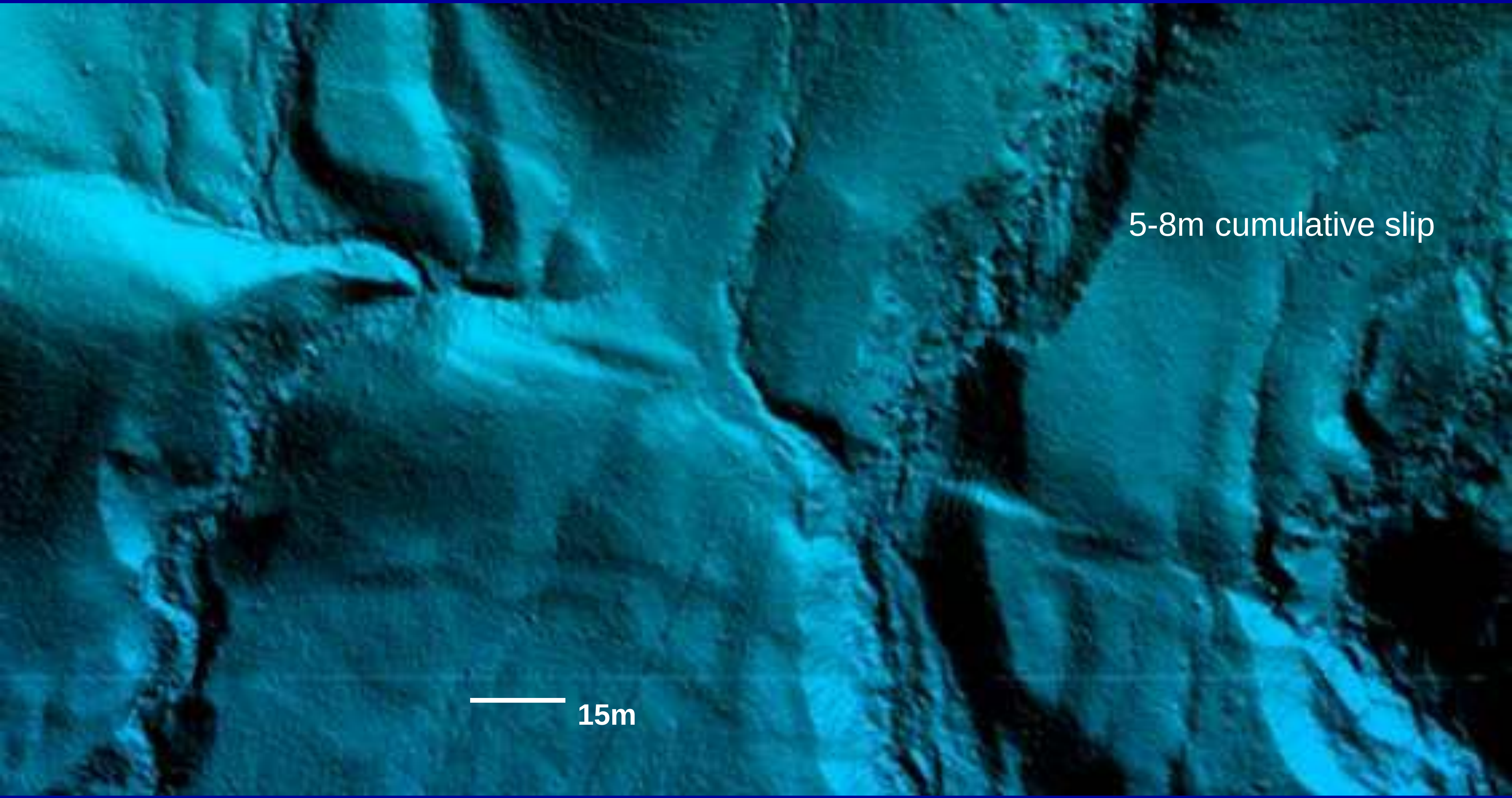
Offset/Deflected channels

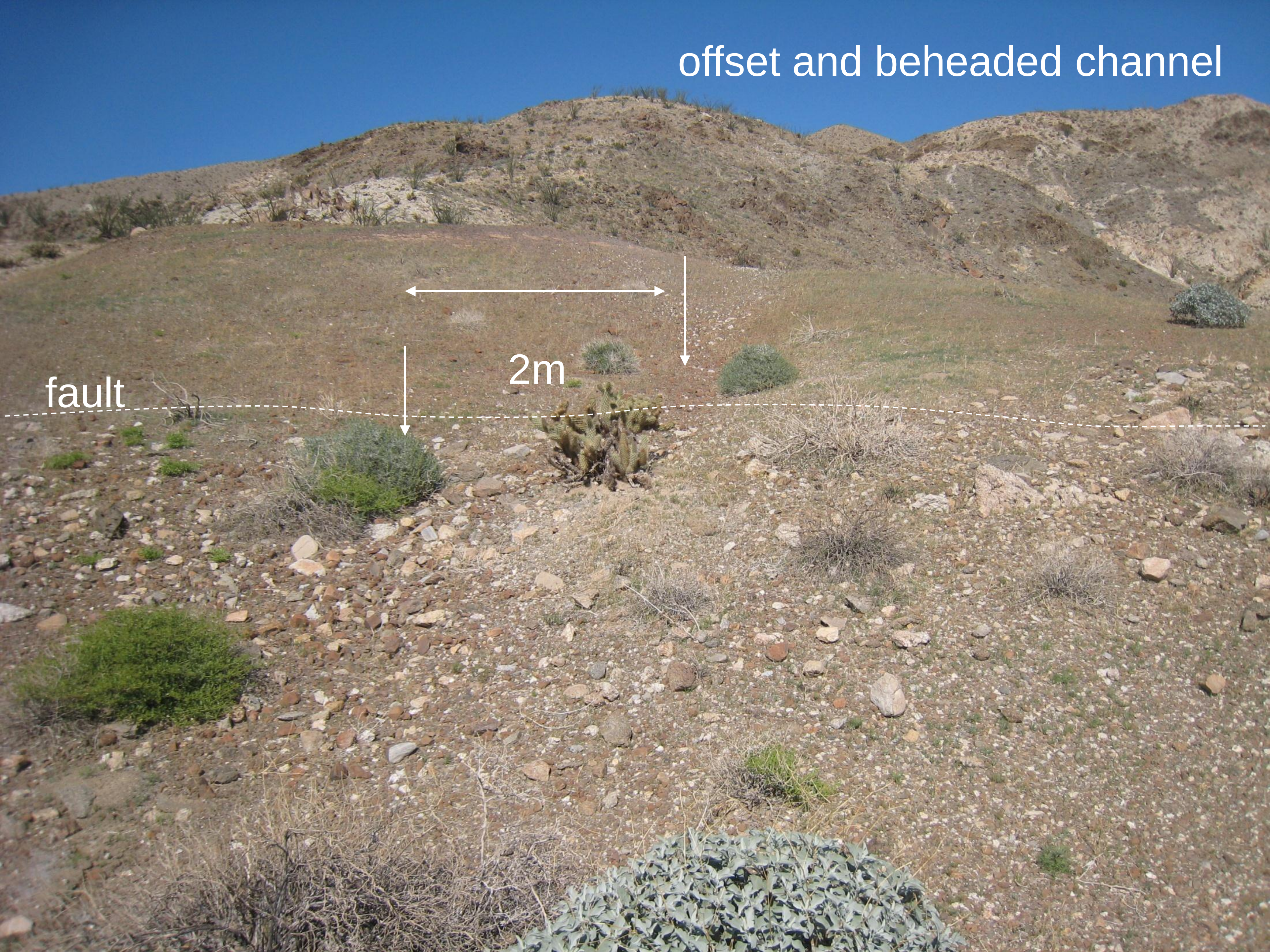
Carizzo plain

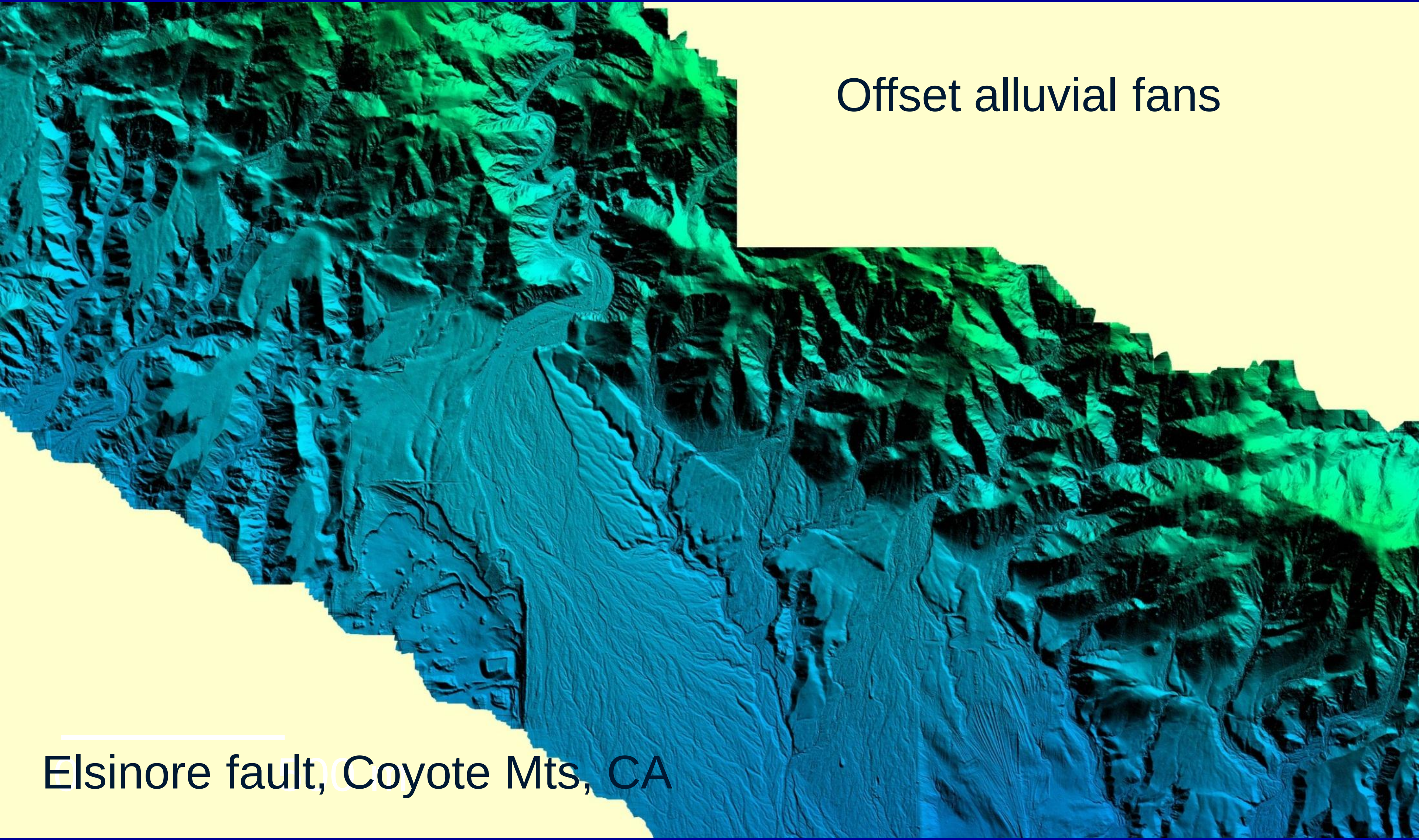

Coyote Mts
0
10 km
Elsinore
Coyote Mts
Laguna Salada fault
0
40 km


extension sag pond
beheaded channels
15m
offset valley side
Elsinore fault, Coyote Mts, CA

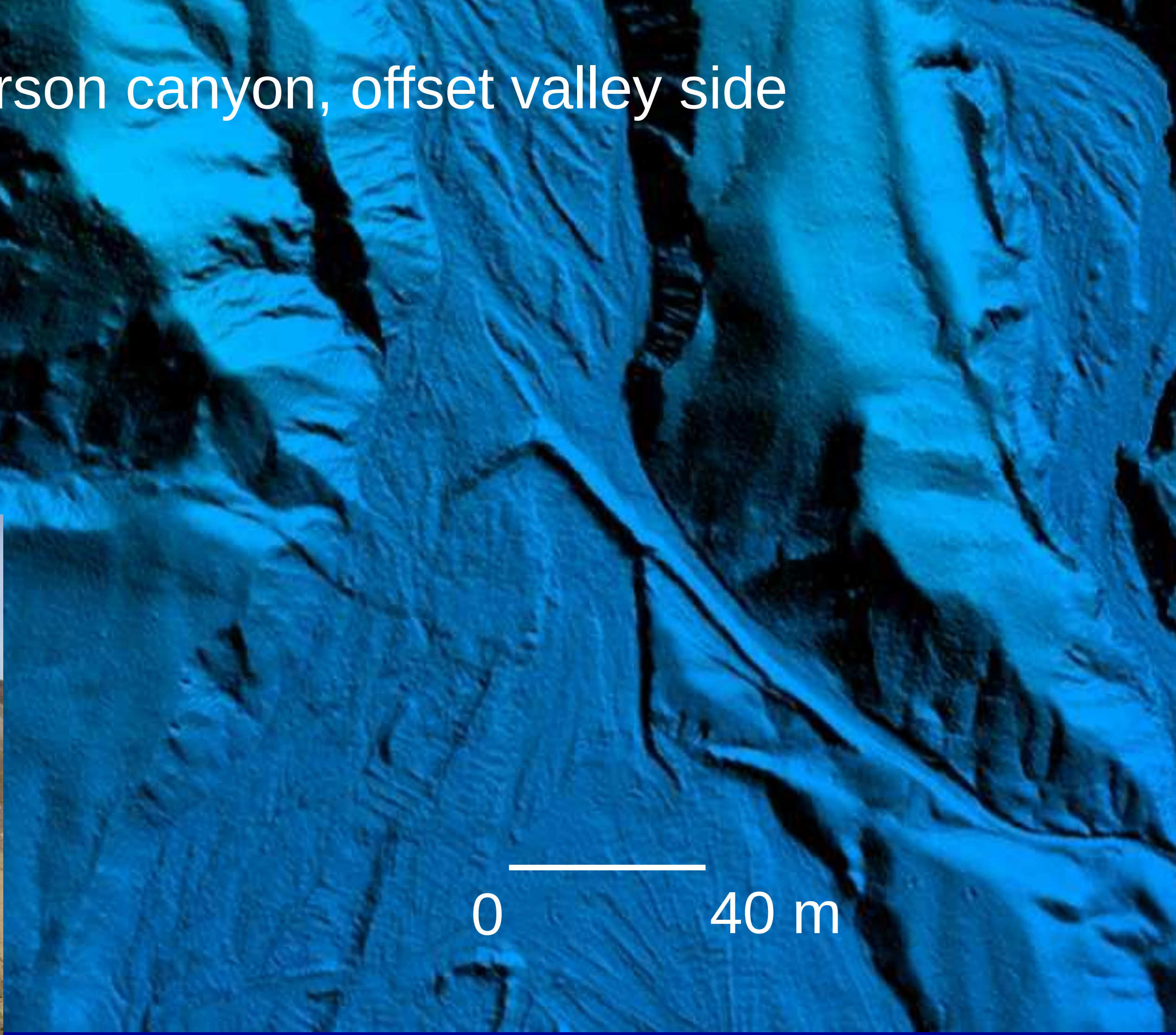
beheaded channels

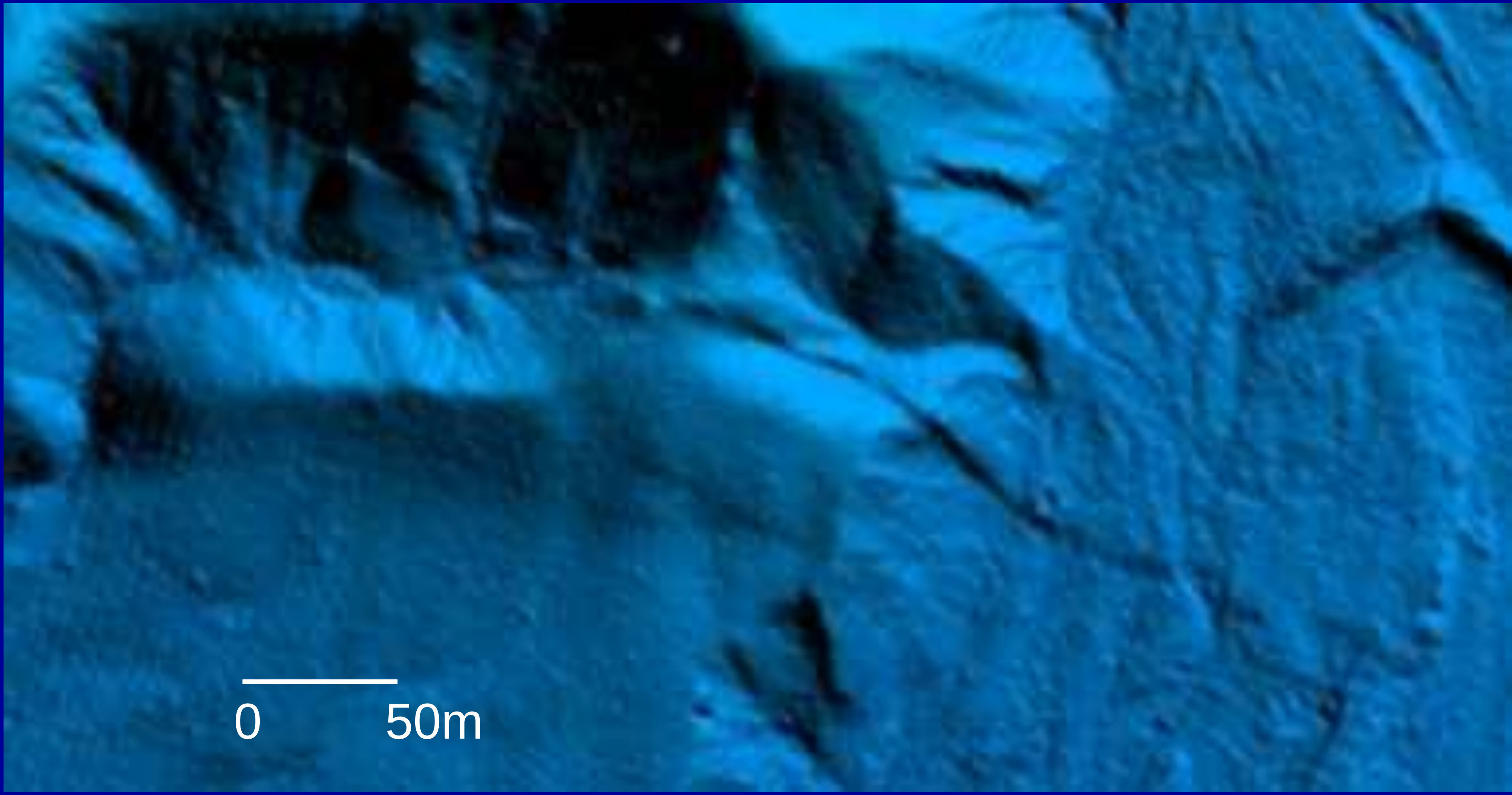



offset and beheaded channel
2m
fault


Offset alluvial fans
Elsinore fault, Coyote Mts, CA

Alverson canyon, offset valley side

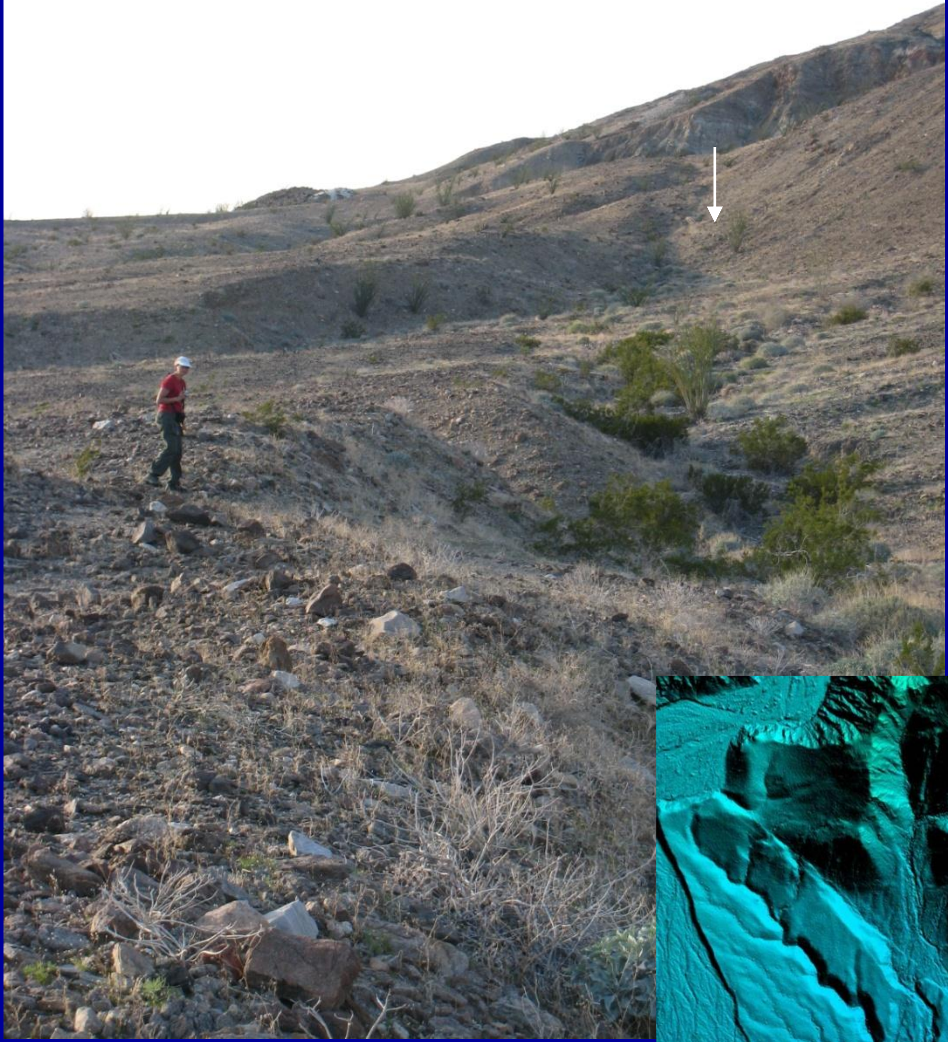


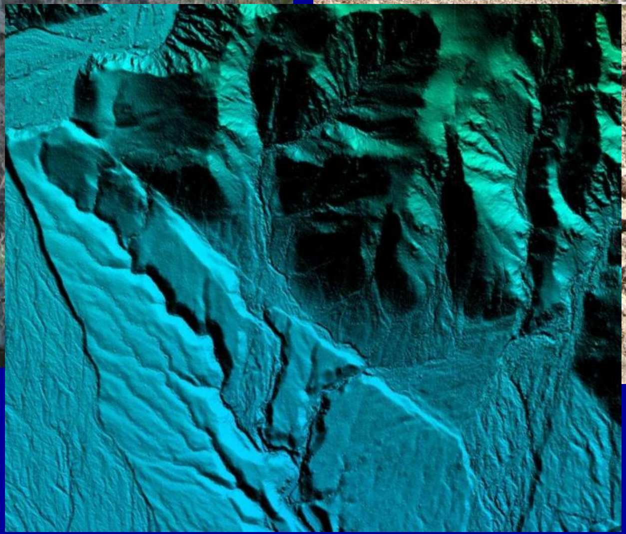

0
50m


offset channels and bars

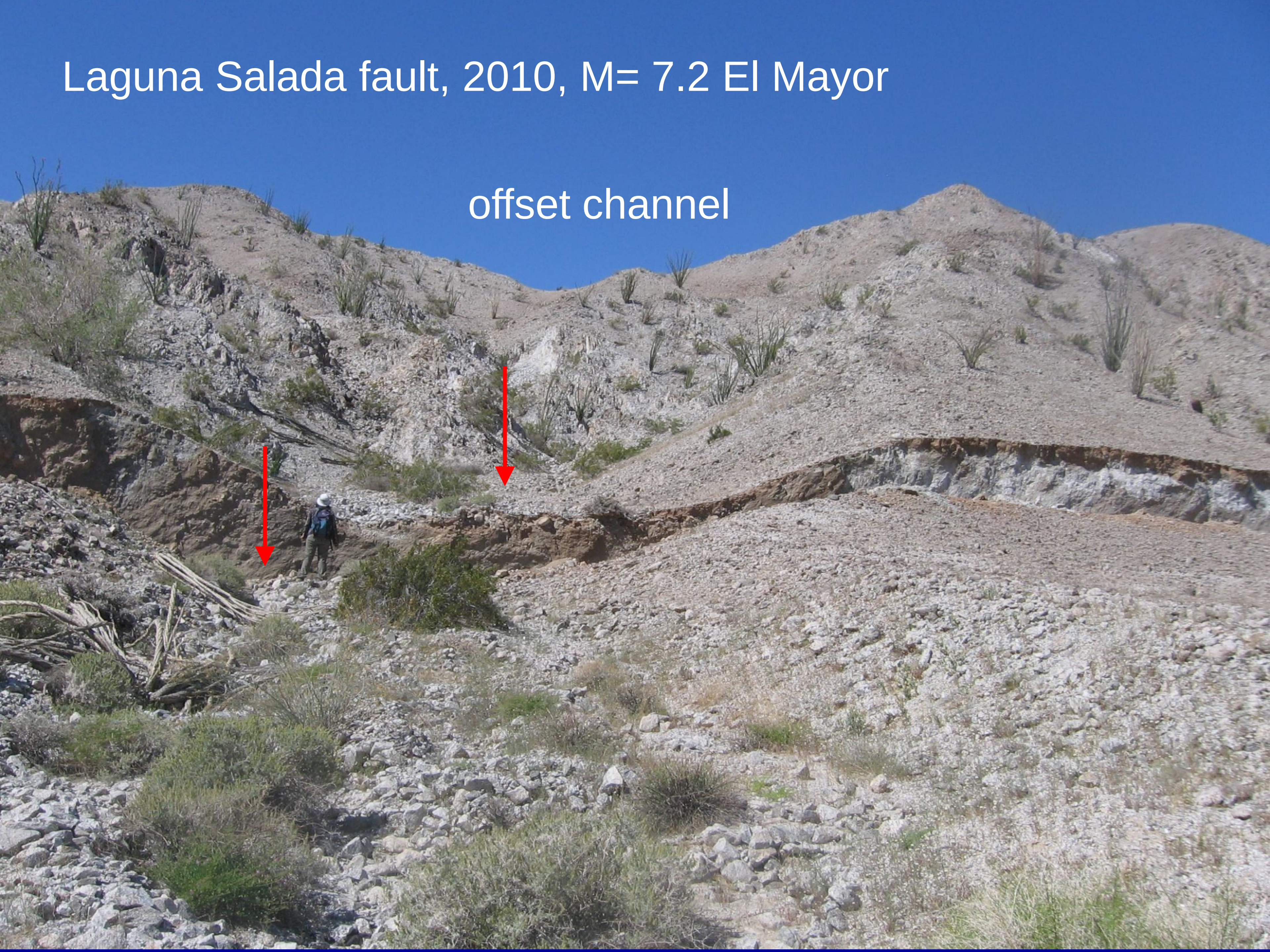
offset channel bars

offset alluvial fan



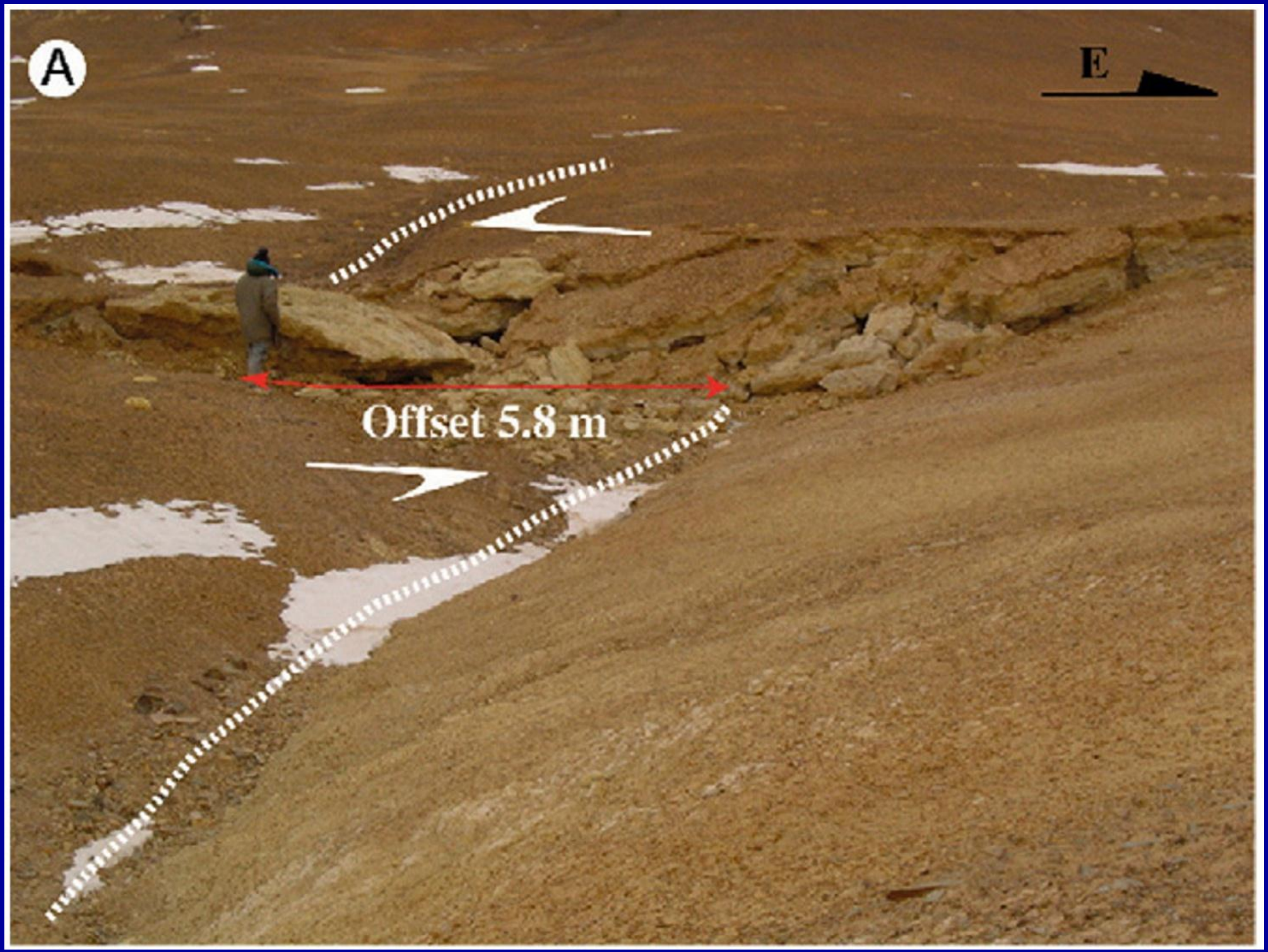


Different lithology – tells us about the amount of offset


Laguna Salada fault, 2010, M= 7.2 El Mayor
offset channel


offset channel


offset valley side



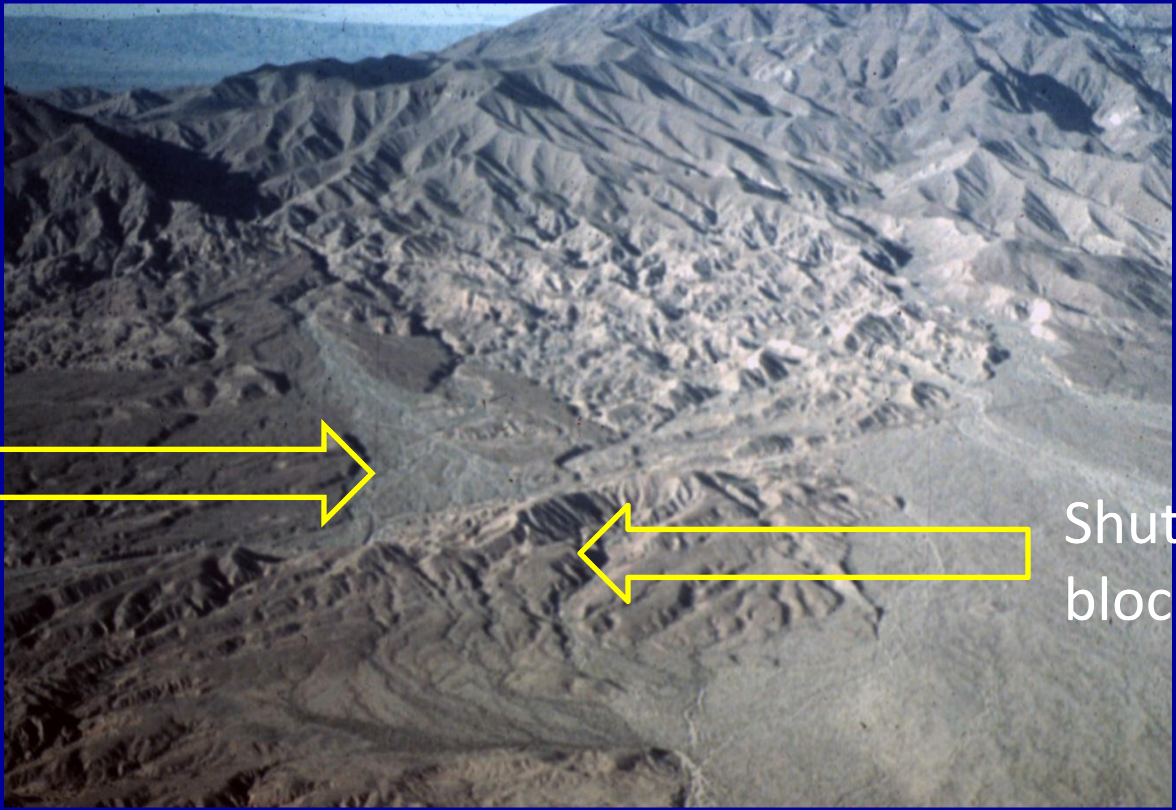
Kunlun fault, Tibet, 2001   M = 7.8

San Jacinto Fault, Southern California


sag
piercing/matching points
Offset channel margin
sag
Denali fault. Photo: Lloyd Cluff, 1973

Shutter Ridge

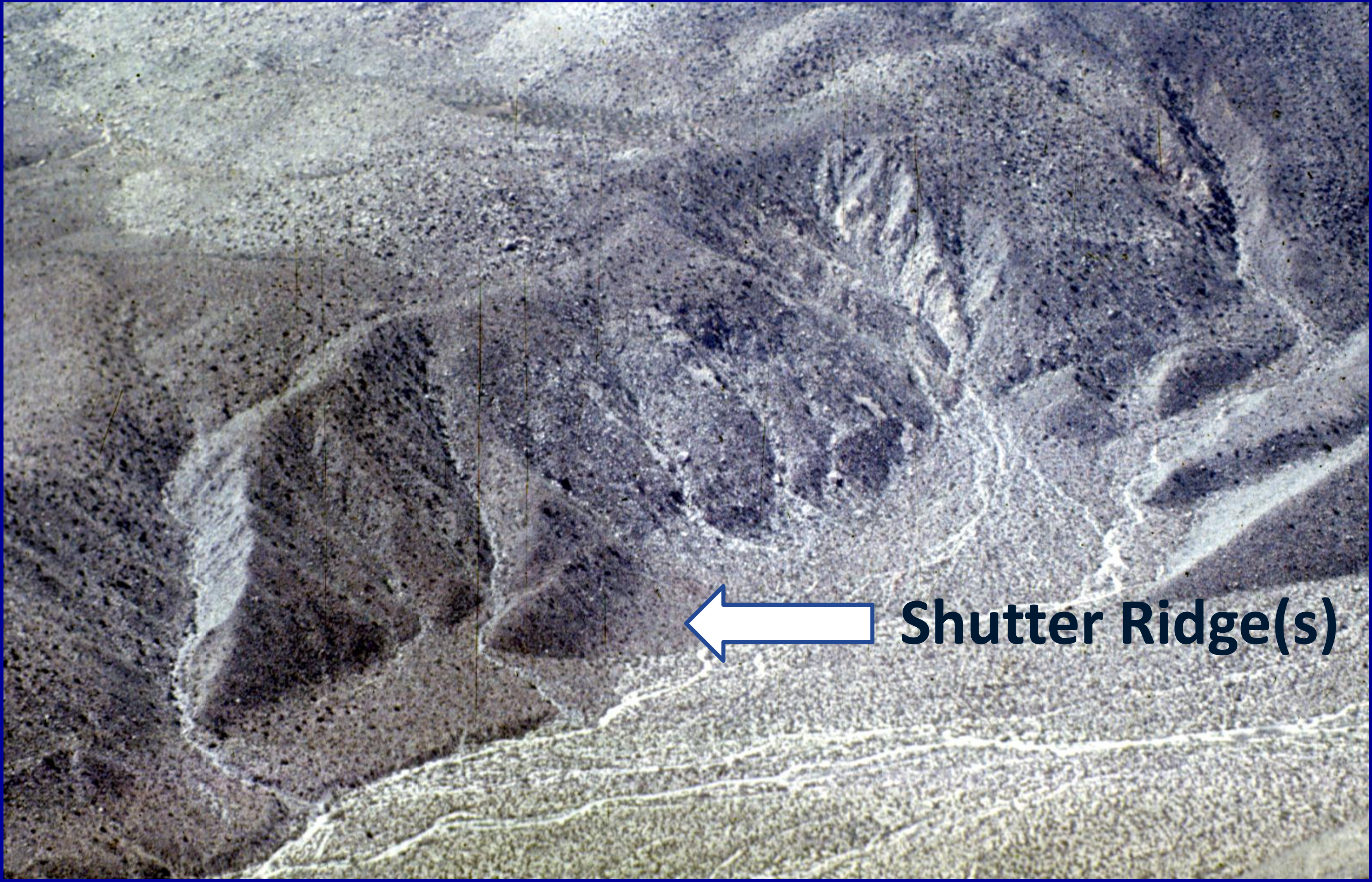
- Hřbet, který se pohyboval podél horizontálního zlomu a zablokoval odtok, údolí



Clark strand of the San Jacinto

Hector Mine Rupture, 1999

San Jacinto Fault, Southern California



Linear valleys

Linear valleys - related to faulting or just fault-line eroding crushed fault zone rocks

Transtension/Transpression

•Both occur at all scales!   Local to regional features
•Controlled by bends in SS fault (local), or overall convergence/divergence along a SS fault (regional)

Transtension

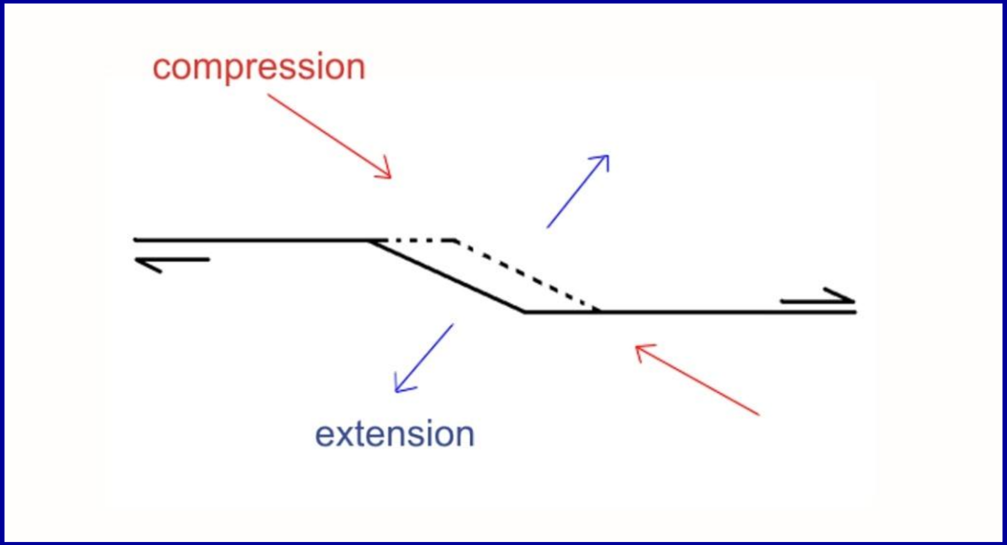
- Simultaneous occurrence of strike-slip faulting and extension

Transpression

- Simultaneous occurrence of strike-slip faulting and shortening

Transtension

- Component of divergence along SS fault (strike-slip)
- Right steps in Dextral (pravostranný) SS fault
- Left steps in Sinistral (levostranný) SS fault



Opening causes a “sag,” or pull-apart basin

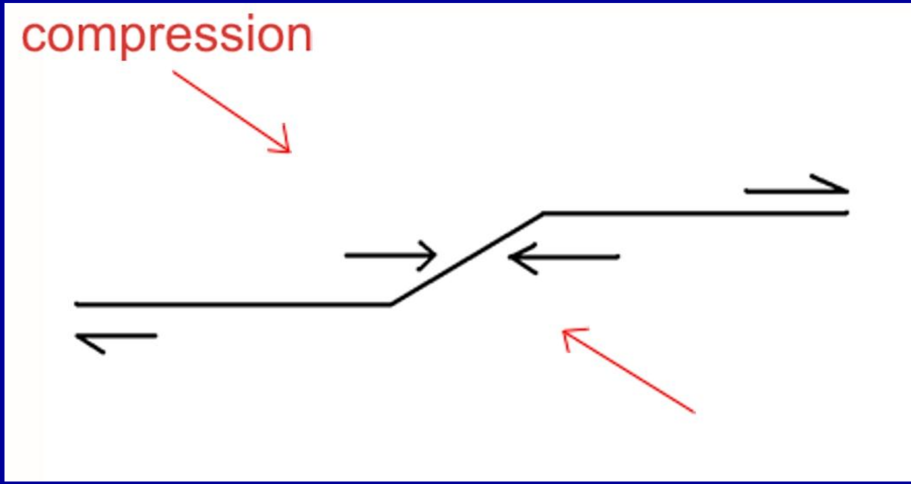
Sag Ponds

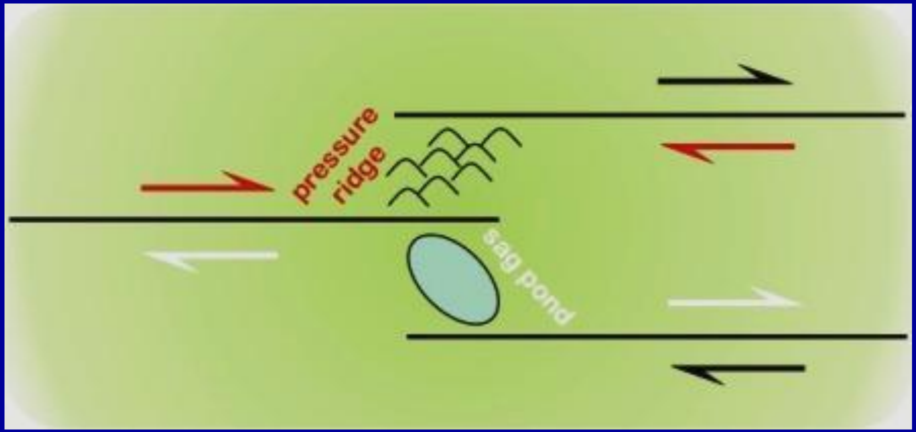
San Andreas

Topographic depression produced by extensional bends or stepovers along a strike-slip fault. It may or may not contain water year-round. Synonymous with pull-apart basin.

Transpression

- Component of convergence along SS fault
- Left step in Dextral SS fault
- Right step in Sinistral SS Fault





Right-step causes a space problem, and a "pressure ridge" is formed

Pressure ridge

A topographic ridge produced by compressional bends or stepovers along a **strike-slip fault**

Small pressure ridge along SAF in Cholame Valley

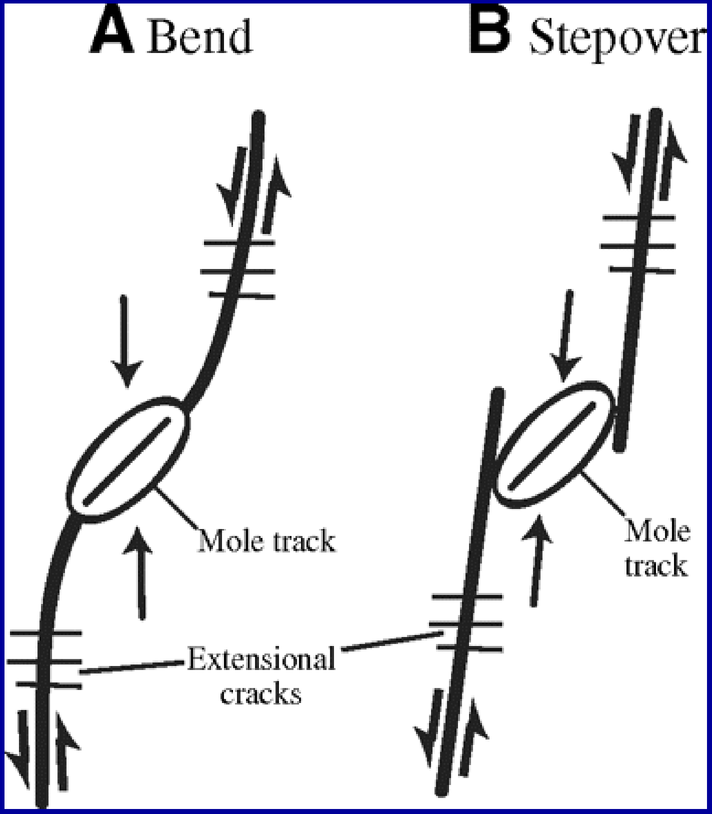
Dragon’s Back Pressure Ridge System
along the San Andreas

Pressure ridge

Thousands Palms – Indio Hills, San Andreas fault

„Mole track“ structure

Material is extruded along the fault by pressure

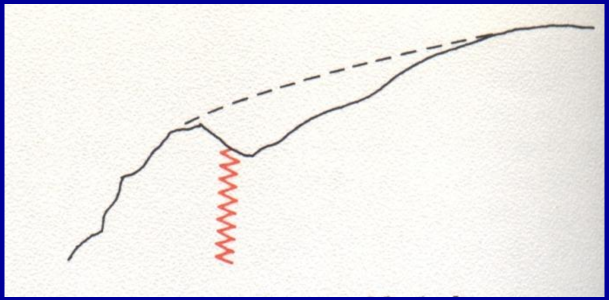


Kunlun fault, Tibet, 2001 M = 7.8

SAF, San Francisco 1906, M = 7.9

Denali fault, Alaska

Side-Hill Benches/Valleys



Parallel faults, Kresna Gorge, Bulgary

Slope inflection along San Andreas Fault

Flat step on the slope