

UAVSAR studies of landslides and tectonics in Mexico, California, and Colorado

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Three UAVSAR projects

- San Francisco Bay area (2008–): Hayward Fault, Berkeley Hills landslides, other faults and deformation
- Slumgullion, SW Colorado (2011–): rapidly moving landslide
- Salton Trough, Mexico (2012–): Postseismic deformation related to 2010 M7.2 earthquake

Creep and Earthquake Potential on the Hayward Fault (AKA Tectonic Time Bomb)

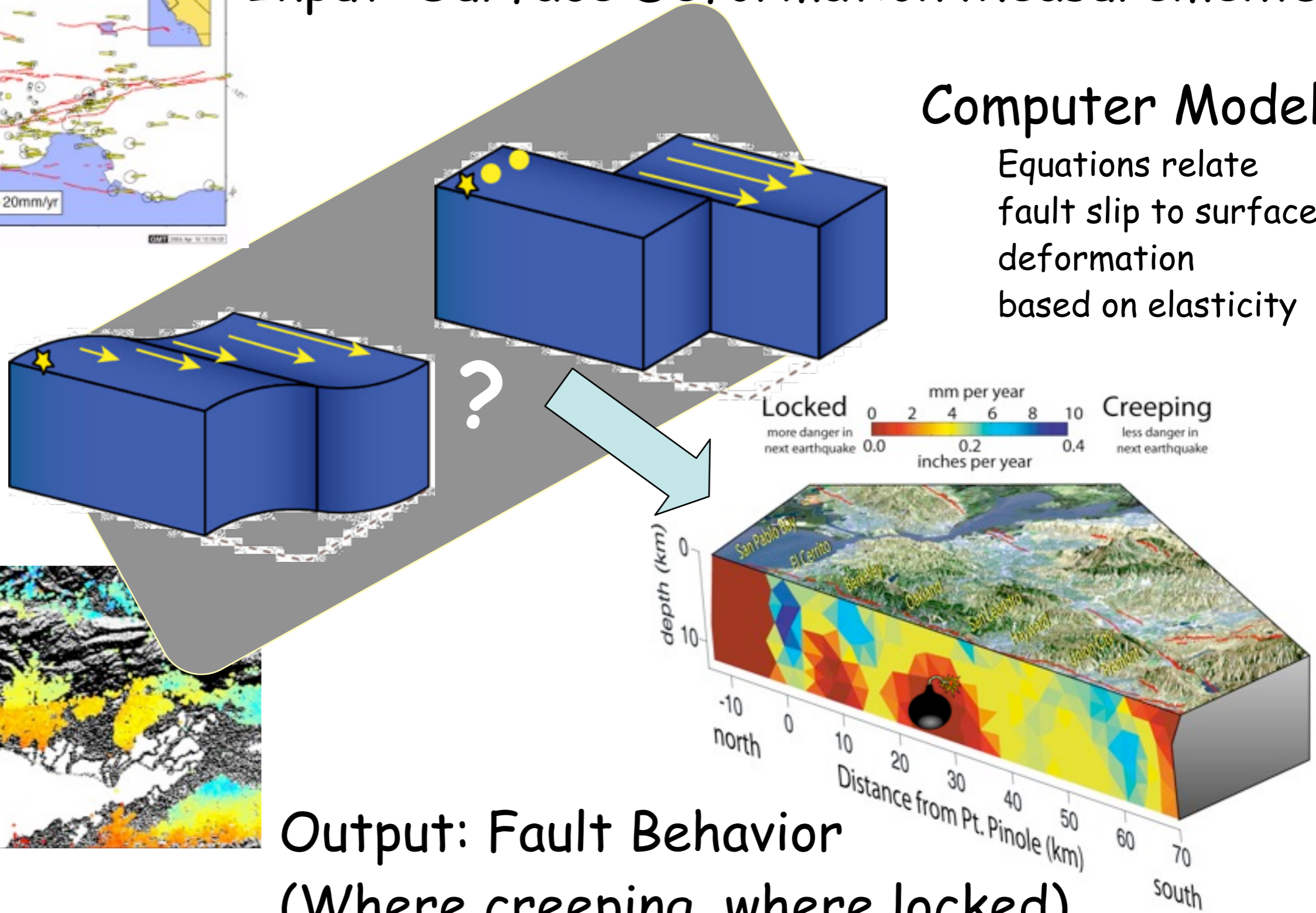


From Surface Deformation to Fault Slip

Input: Surface Deformation Measurements

Computer Model

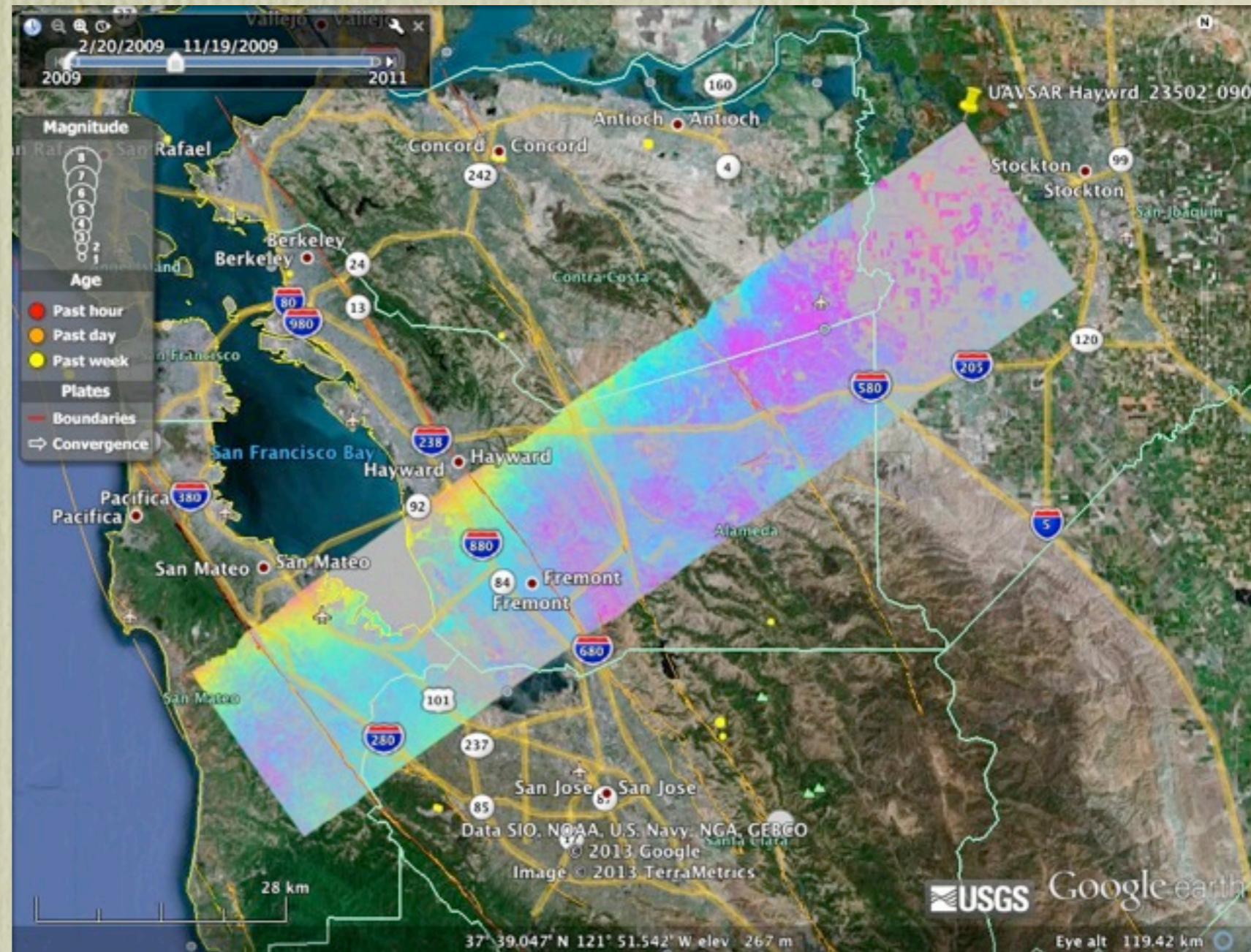
Equations relate fault slip to surface deformation based on elasticity



Output: Fault Behavior
(Where creeping, where locked)

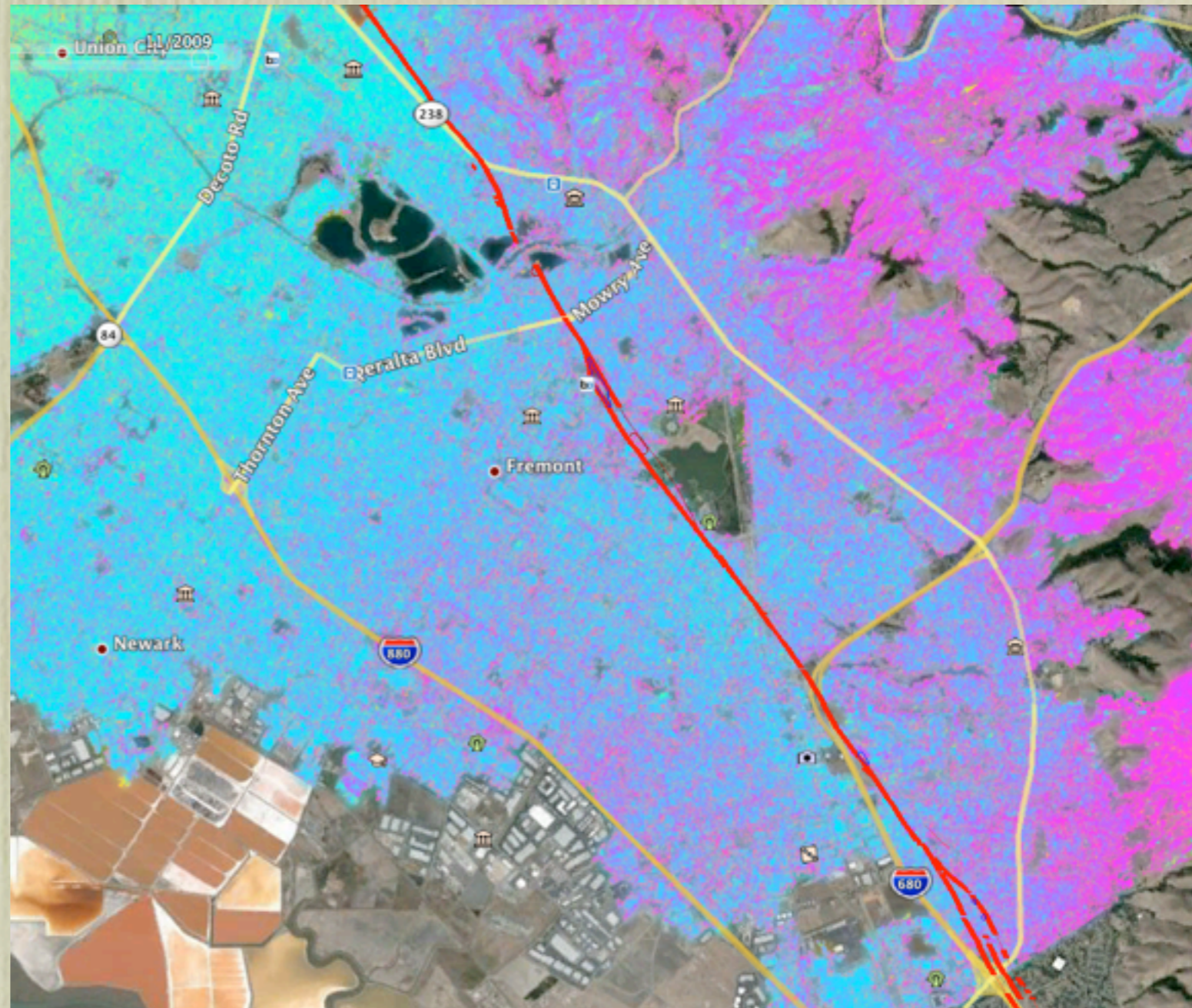
Hayward line 23502 Fremont

- Southern Hayward Fault at Fremont
- 9 acquisitions Feb. 2009–Nov. 2012
- (plus 5 engineering in 2008)
- 3 RPI products released so far
- longest RPI interval 272 days



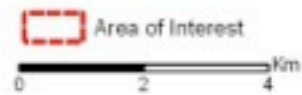
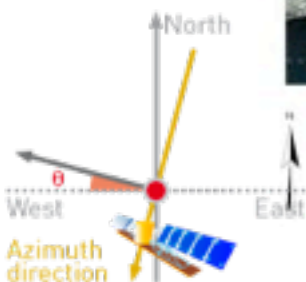
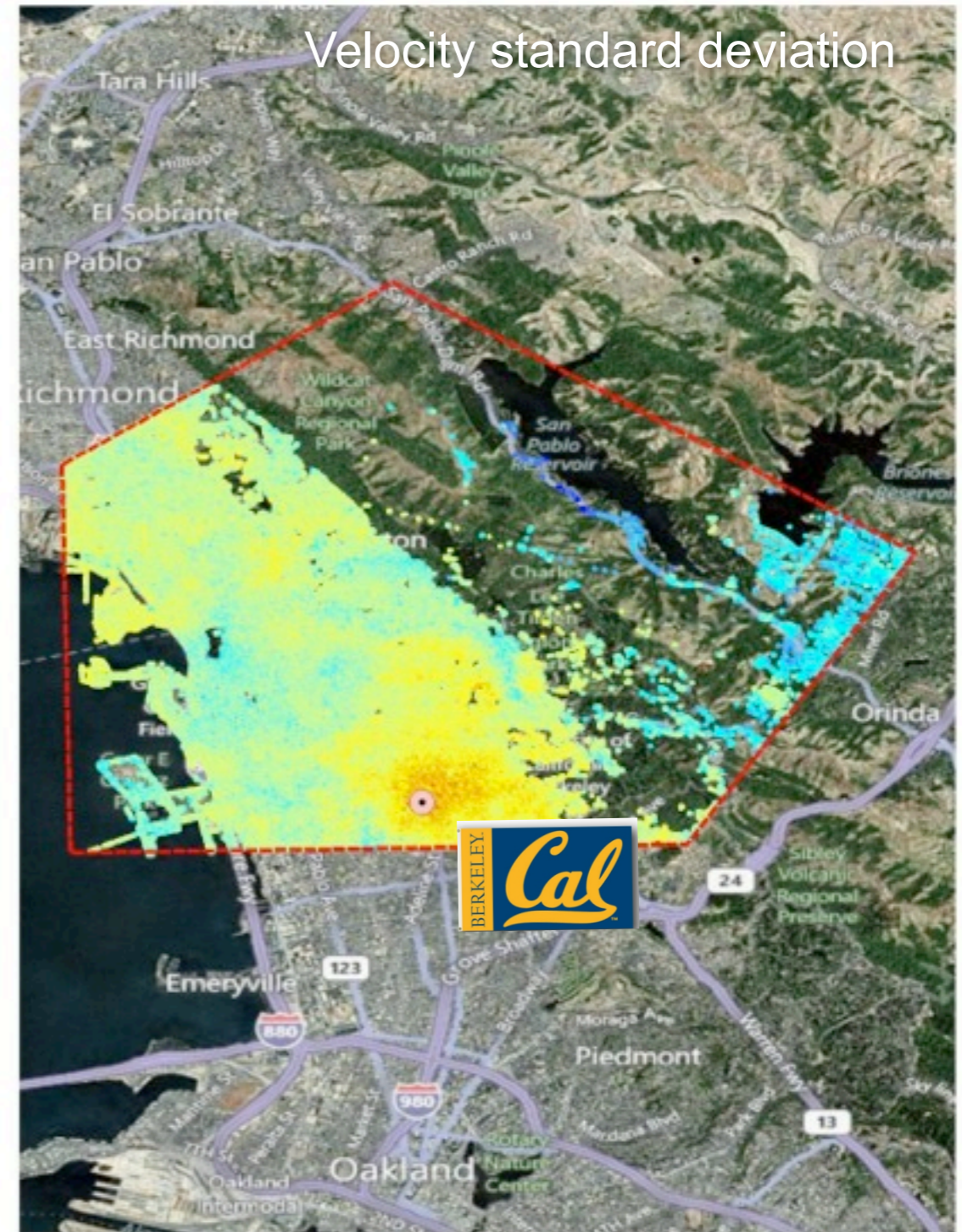
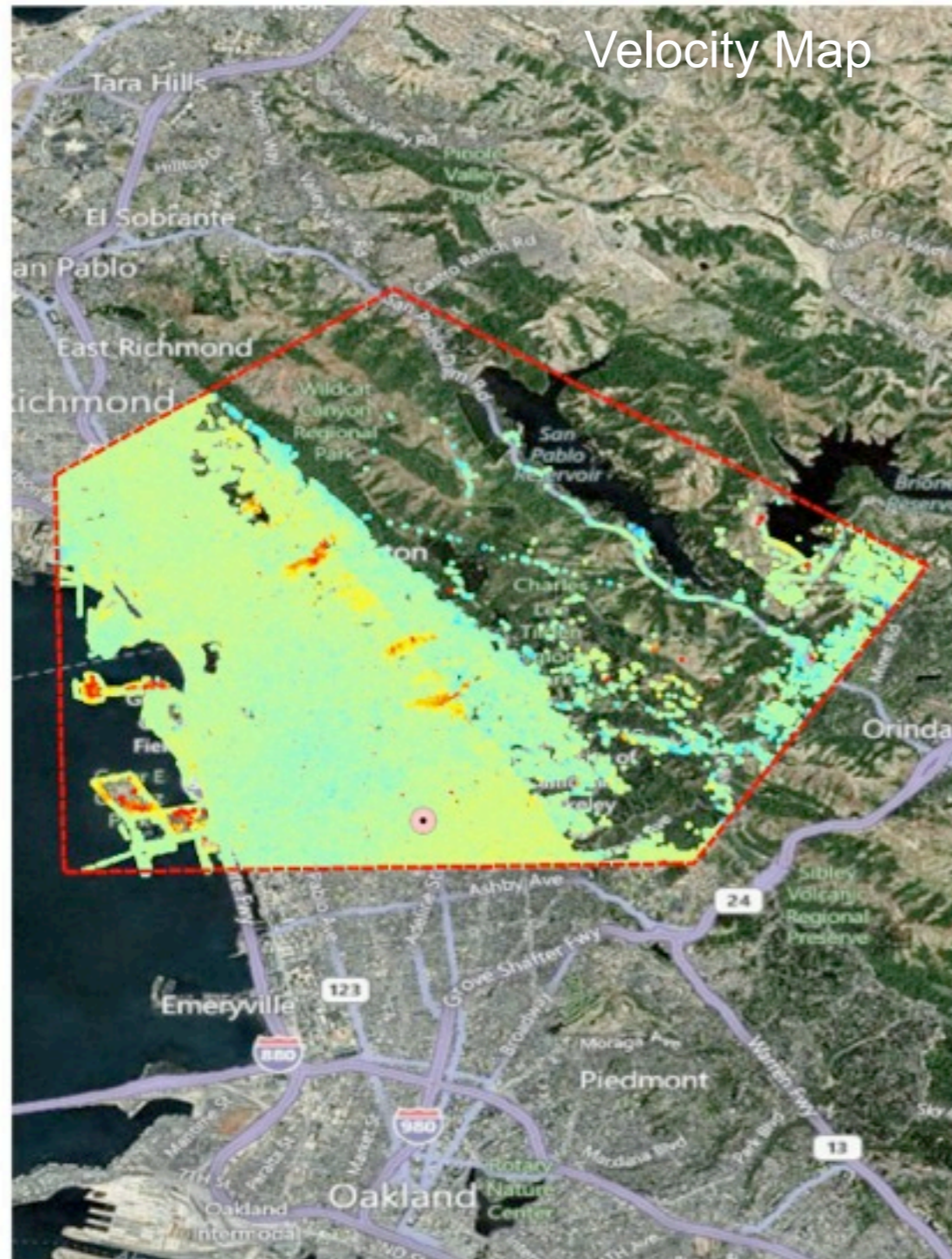
Fremont 272 days line 23502

- Detail of 272-day RPI from 2009
- City of Fremont
- Hayward Fault red lines
- 2-pi (11.8 cm) color wrap
- Approximately 7 mm/yr creep rate
- Not yet detectable



TRE TerraSAR-X 2009–2011

SqueeSAR™ analysis 34 scenes

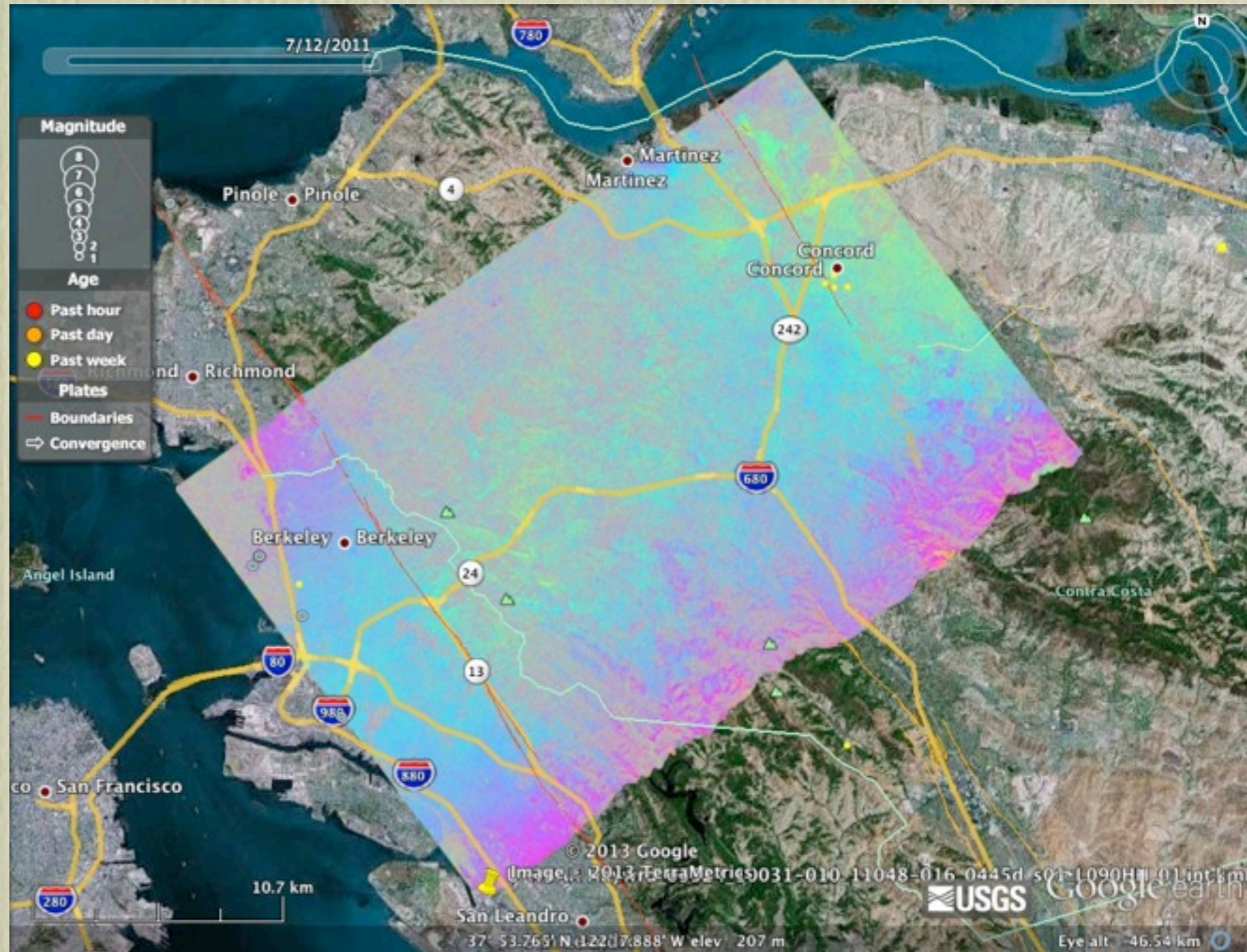


-10 mm/yr +10

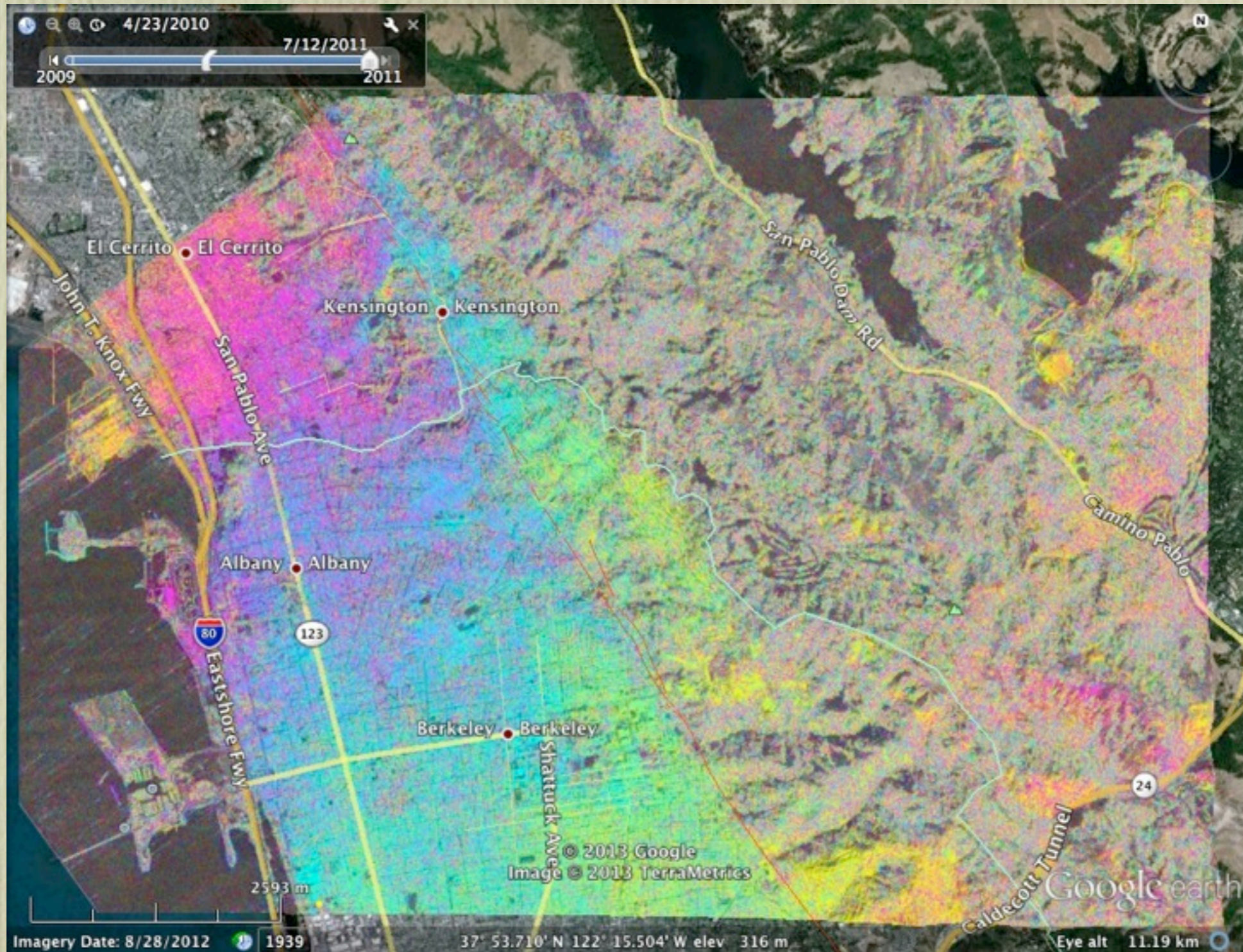


Hayward line 05524 Berkeley

- One of three key lines over Berkeley
- Imaged with 15302, 34001 4 times/year
- 15 acquisitions Nov. 2009–Jan. 2013
- 6 RPI products released so far
- longest interval 445 days

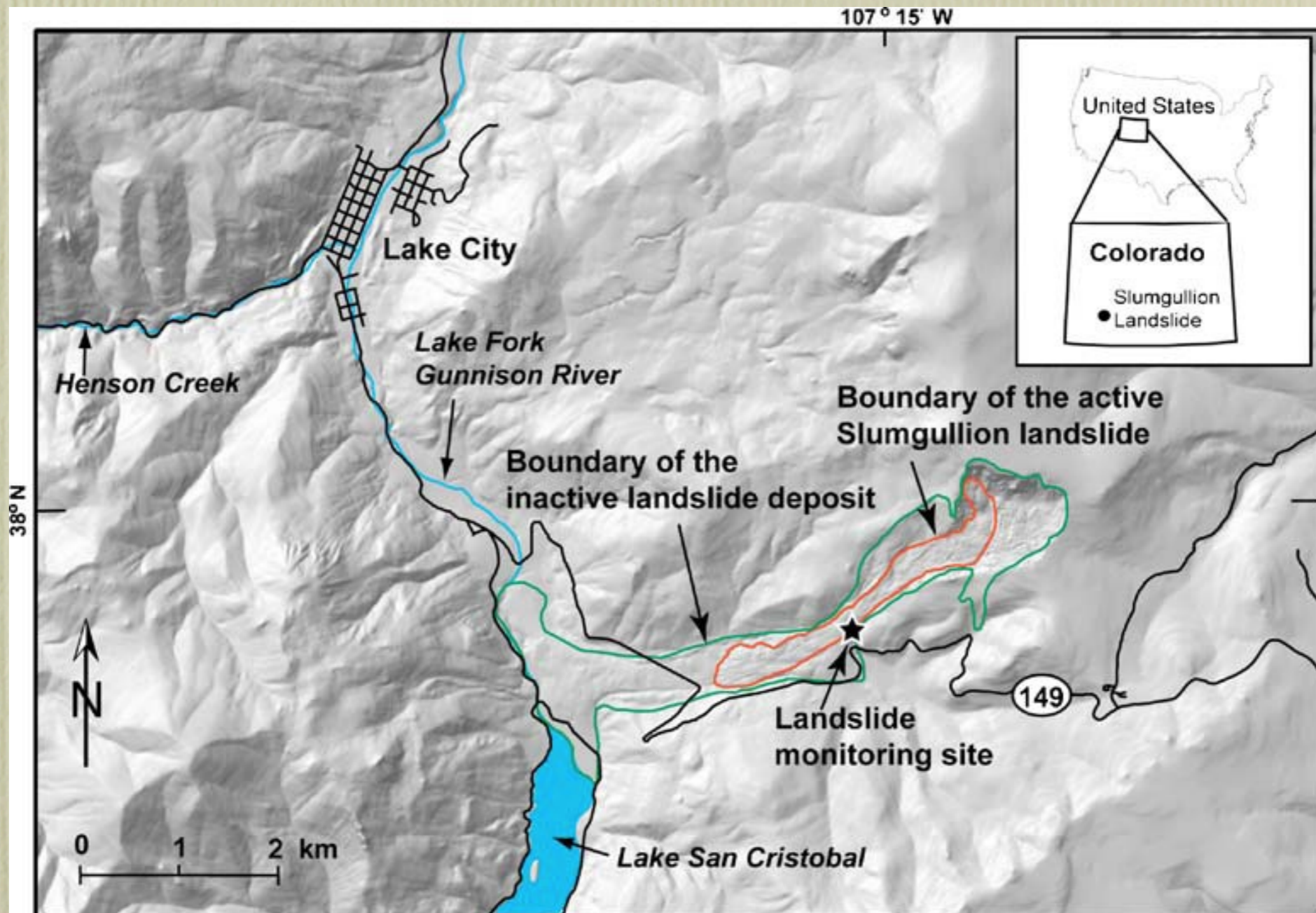


Berkeley 445-day line 05524



- Slant-range P.S. filter, unwrapped with SNAPHU, geocoded
- rewrapped with 2.5 radian (~5 cm) color wrap

Slumgullion Landslide



From Schulz W.H. et al. (2009) Relations between hydrology and velocity of a continuously moving landslide—evidence of pore-pressure feedback regulating landslide motion? *Landslides*. 6:181–190

Slumgullion Landslide

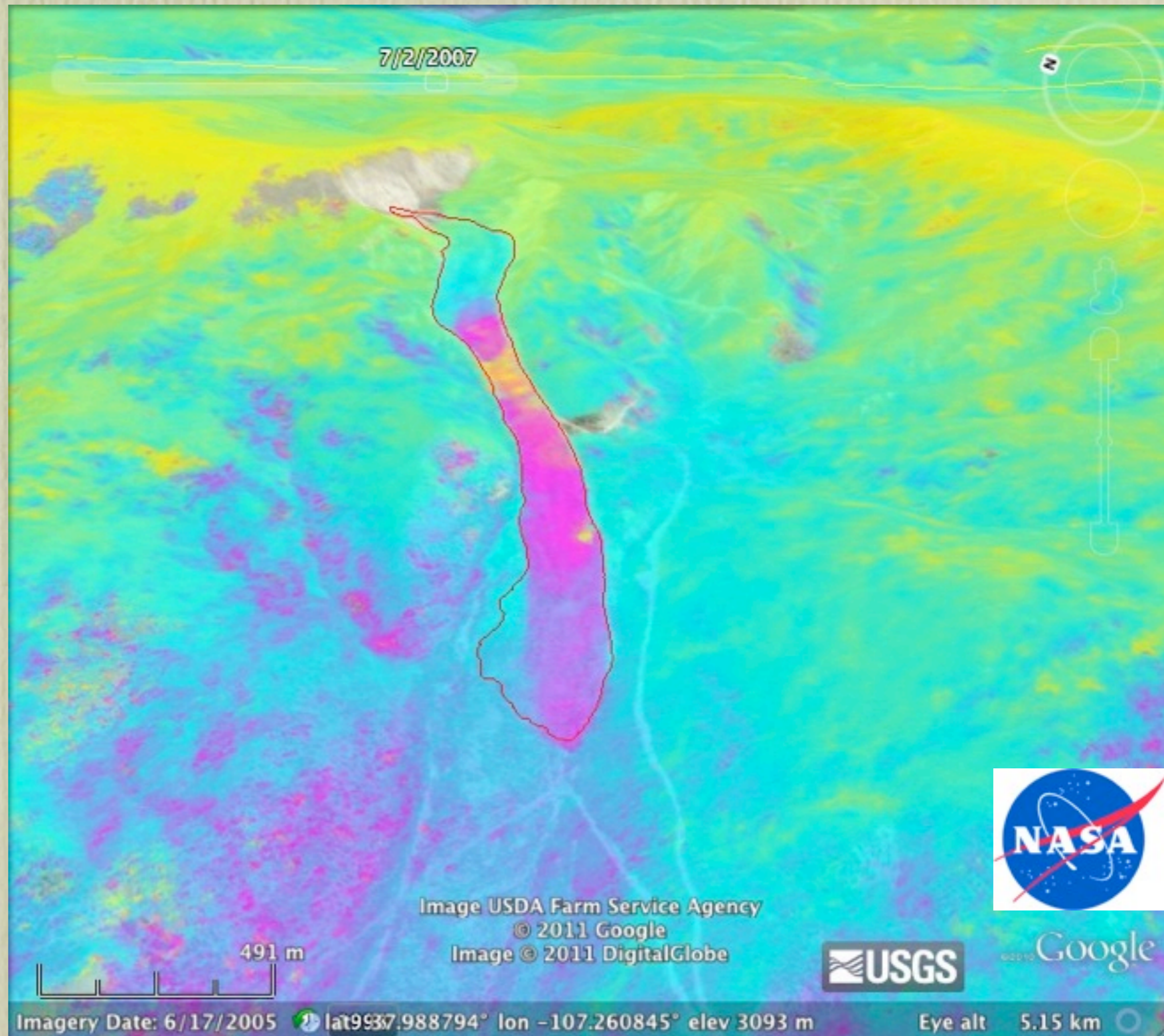
- landslide or earth flow in southwest Colorado, USA
- rapid continuous motion
- up to 1.5 cm/day at fastest part
- red outline presently active portion mapped by USGS



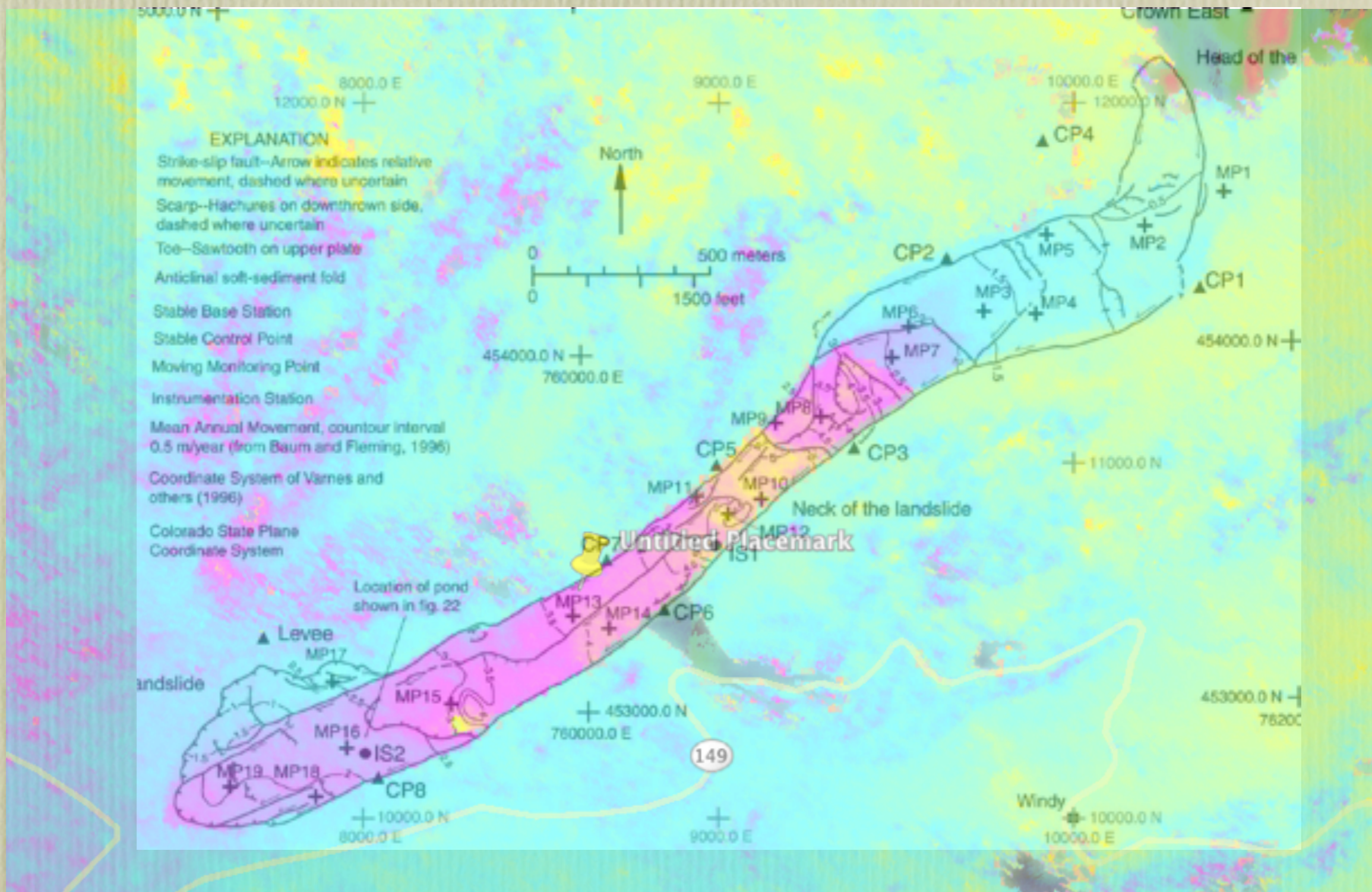
oblique perspective looking east

UAVSAR 7-day RPI

- 7-day time interval
August 2011
- Line 30502
- up to 65 mm of displacement
- oblique view up the landslide
- strong atmospheric water vapor signal

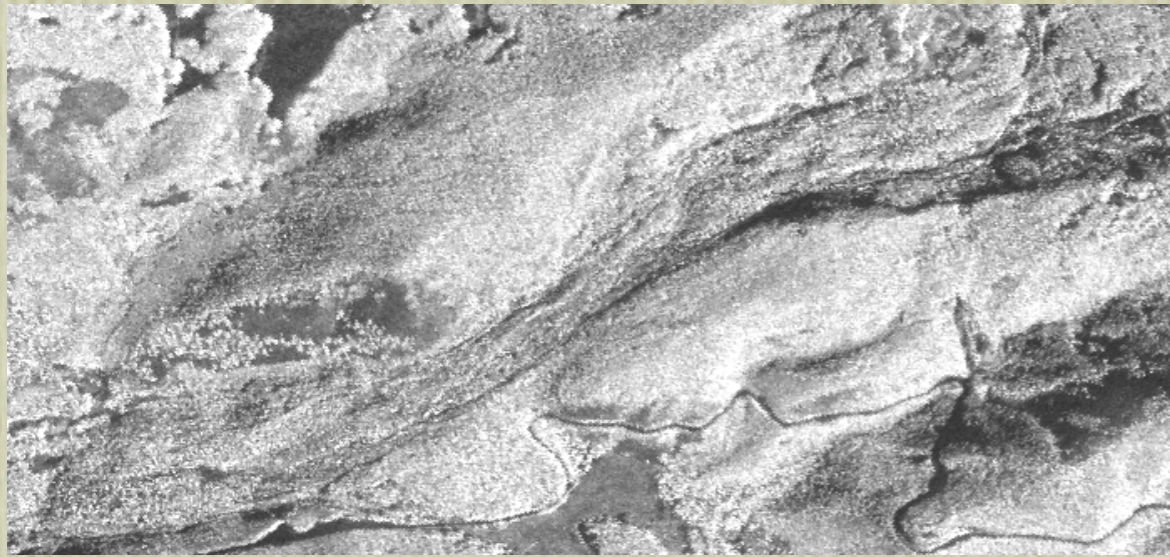


Line 30502 August 2011

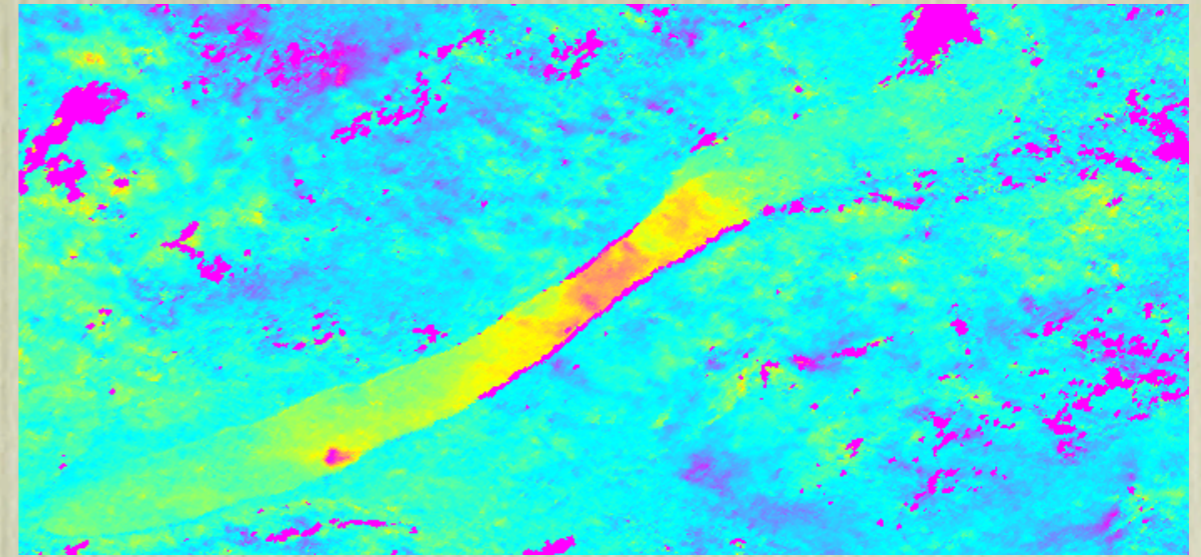


Matches ground mapping of landslide kinematic units

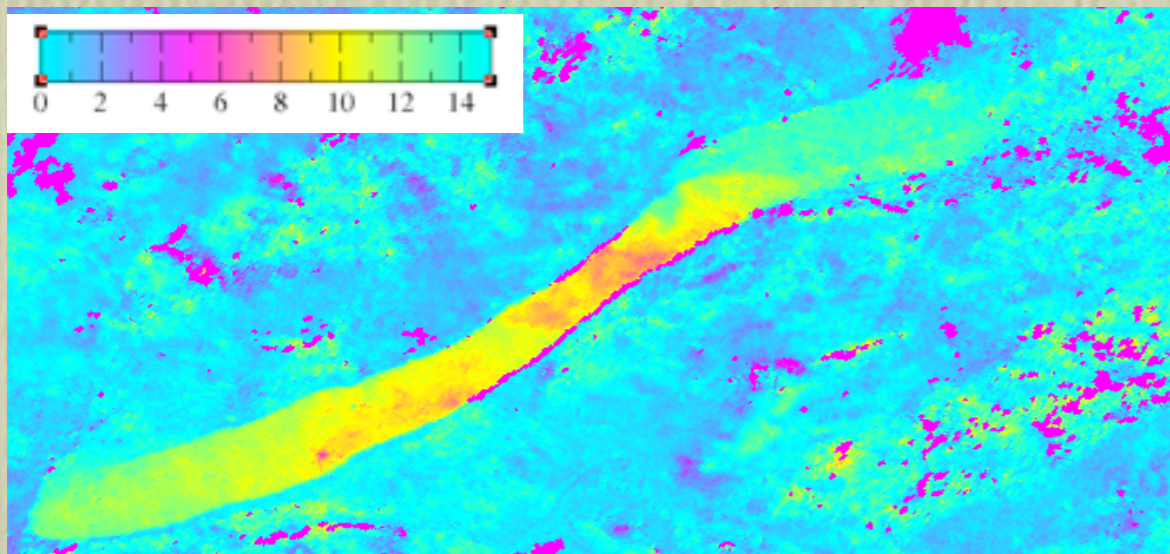
Slumgullion 3-D motion



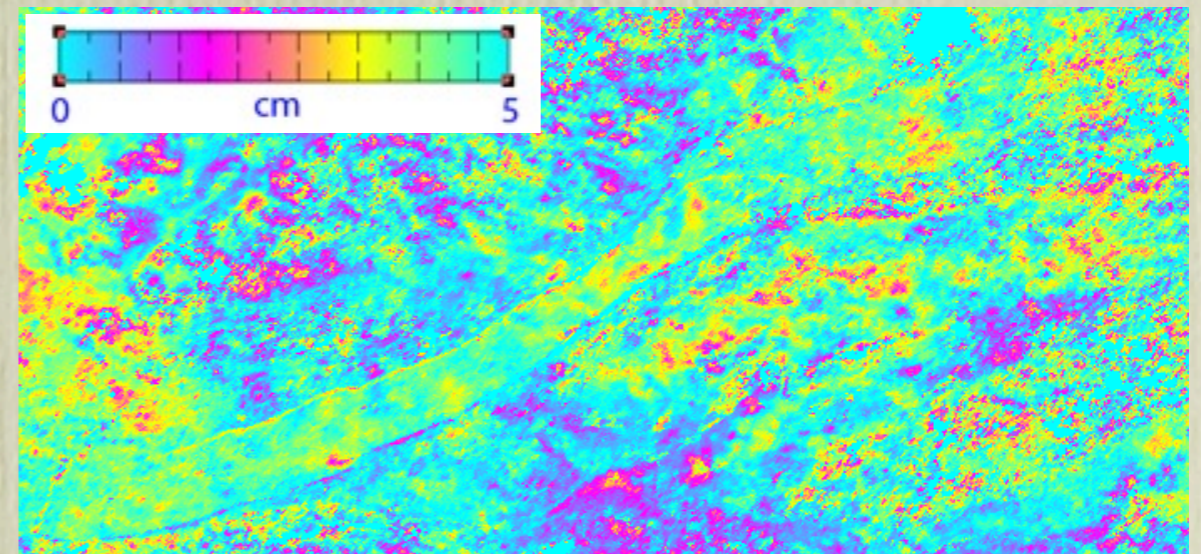
H035 amplitude



North



East

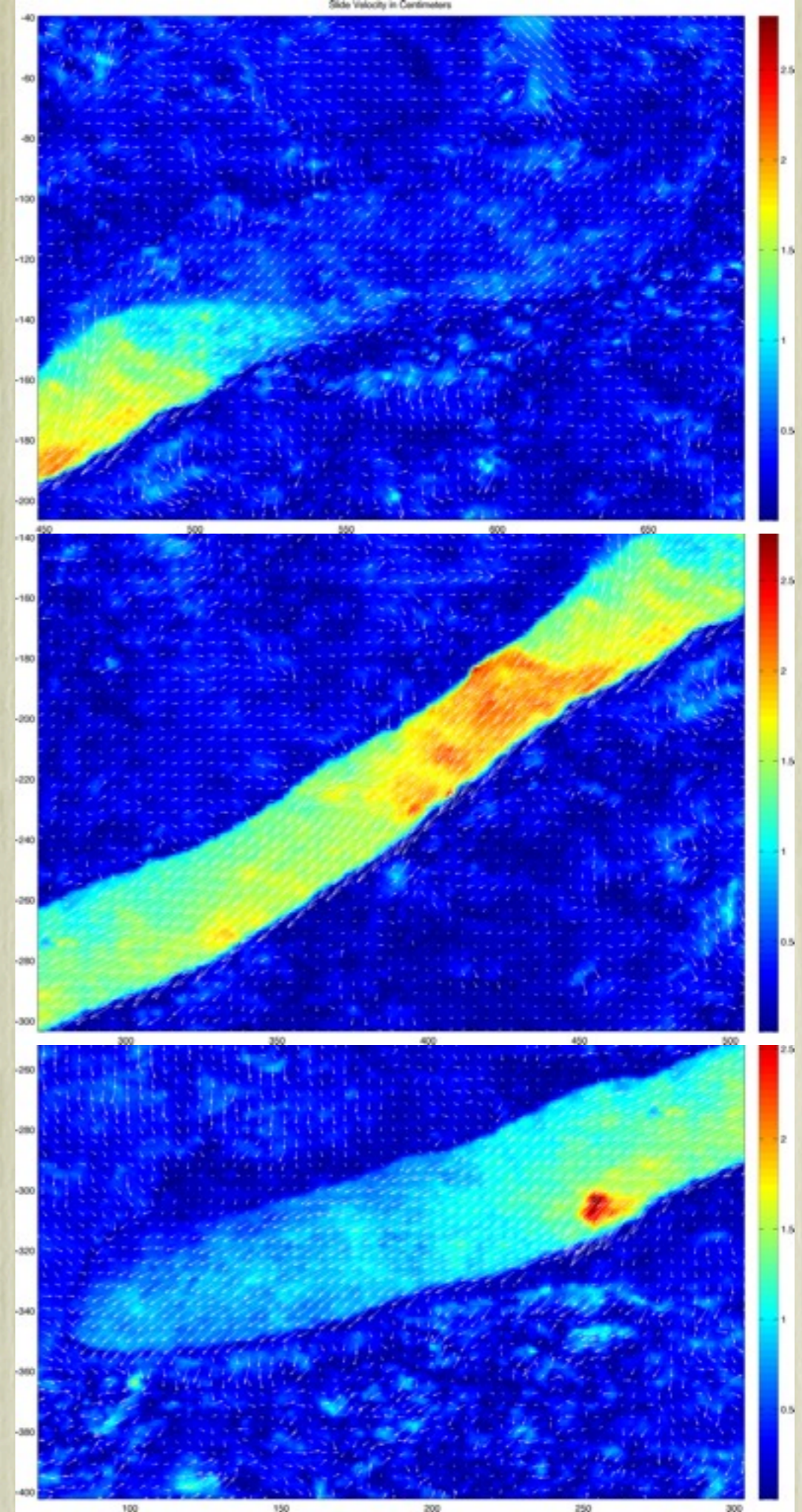


Up

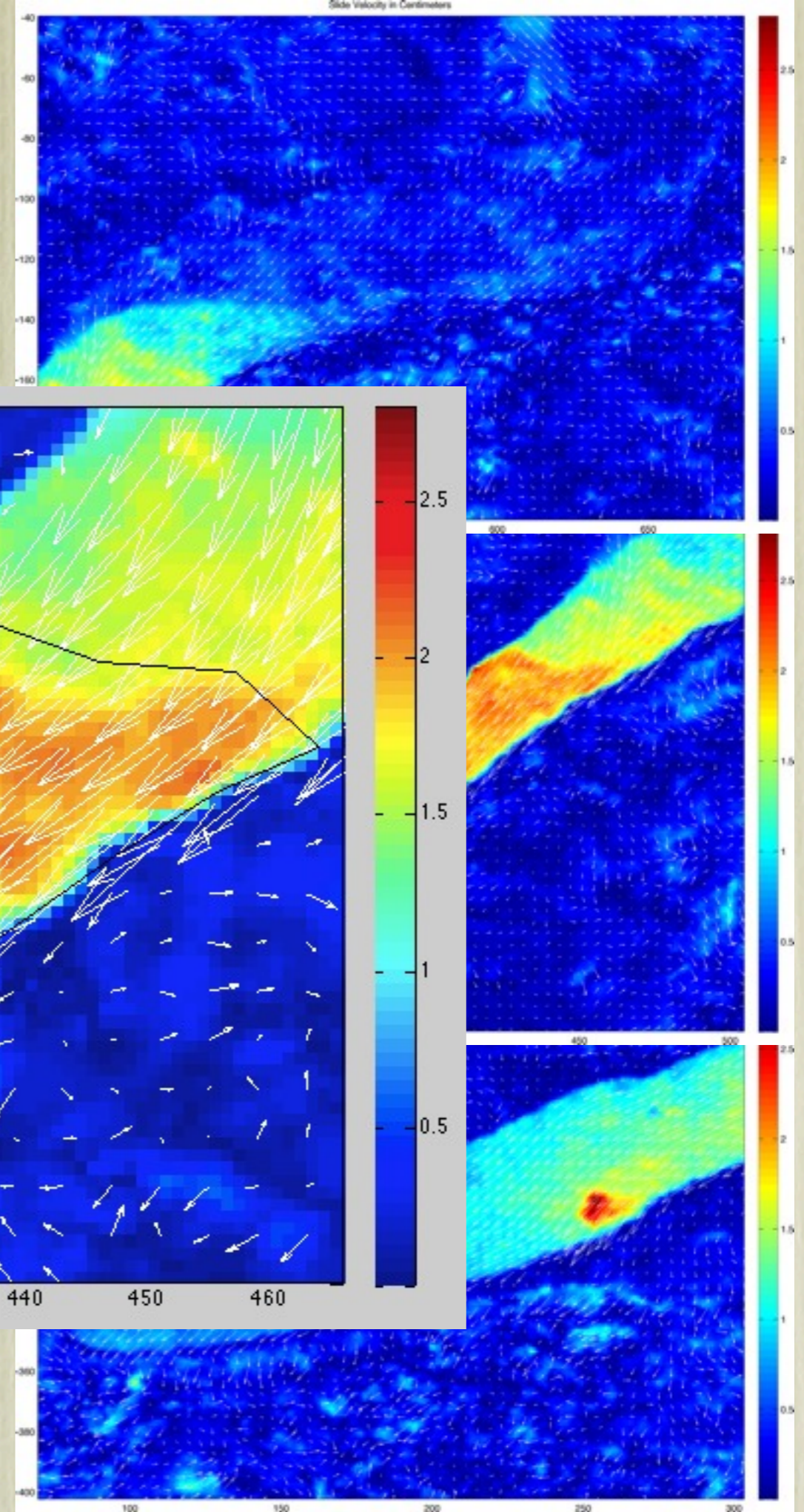
- April 2012
- Four lines 30502, 12502, 03501, 21501
- 7-day time interval
- 15 cm wrap horizontals (E,N)
- 5cm wrap vertical

Slumgullion vector 3D

- Horizontal motion vectors average over small windows
- Fastest motion in central narrowest section
- Small piggy-back landslide near toe double velocity
- maximum rate ~ 2 cm/day

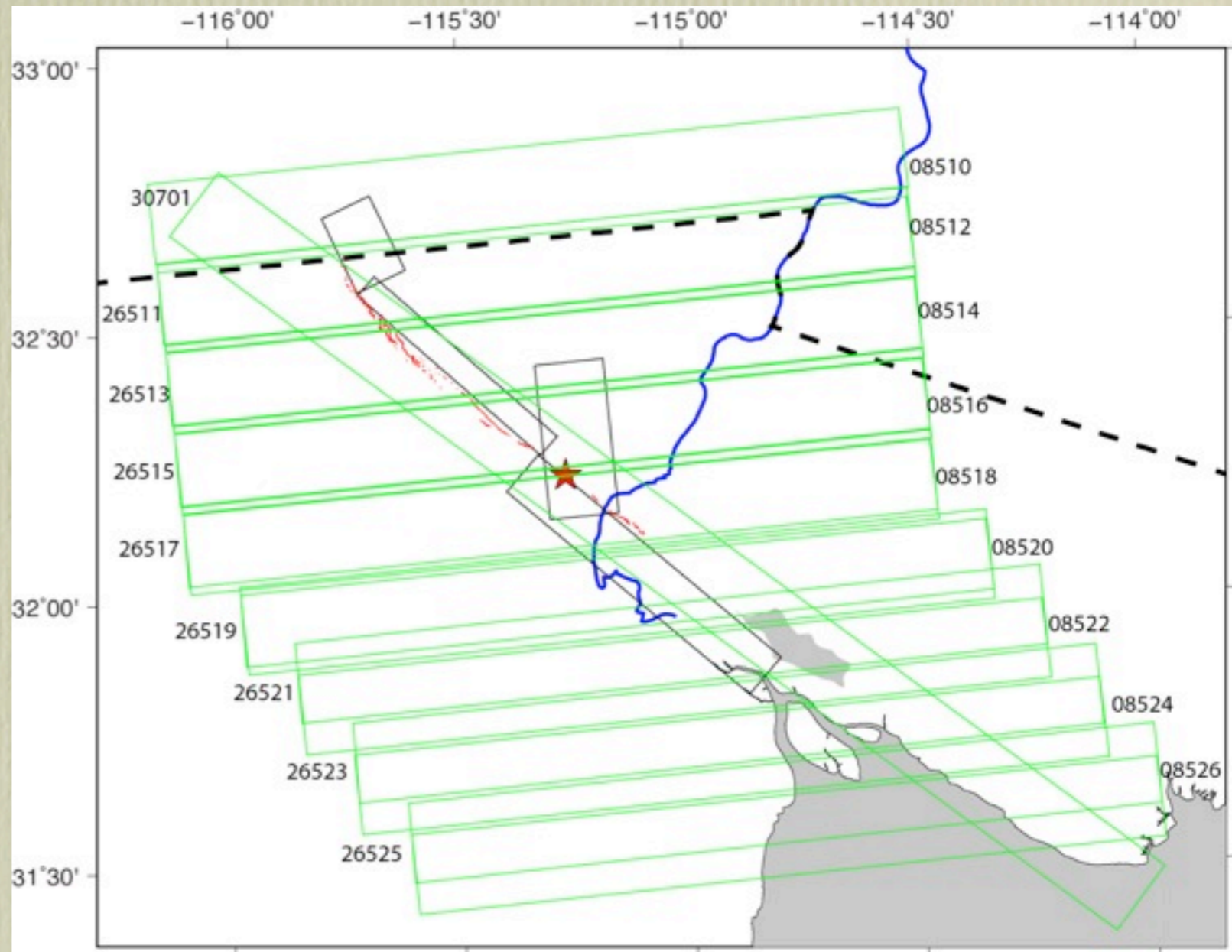


Slumgullion vector 3D

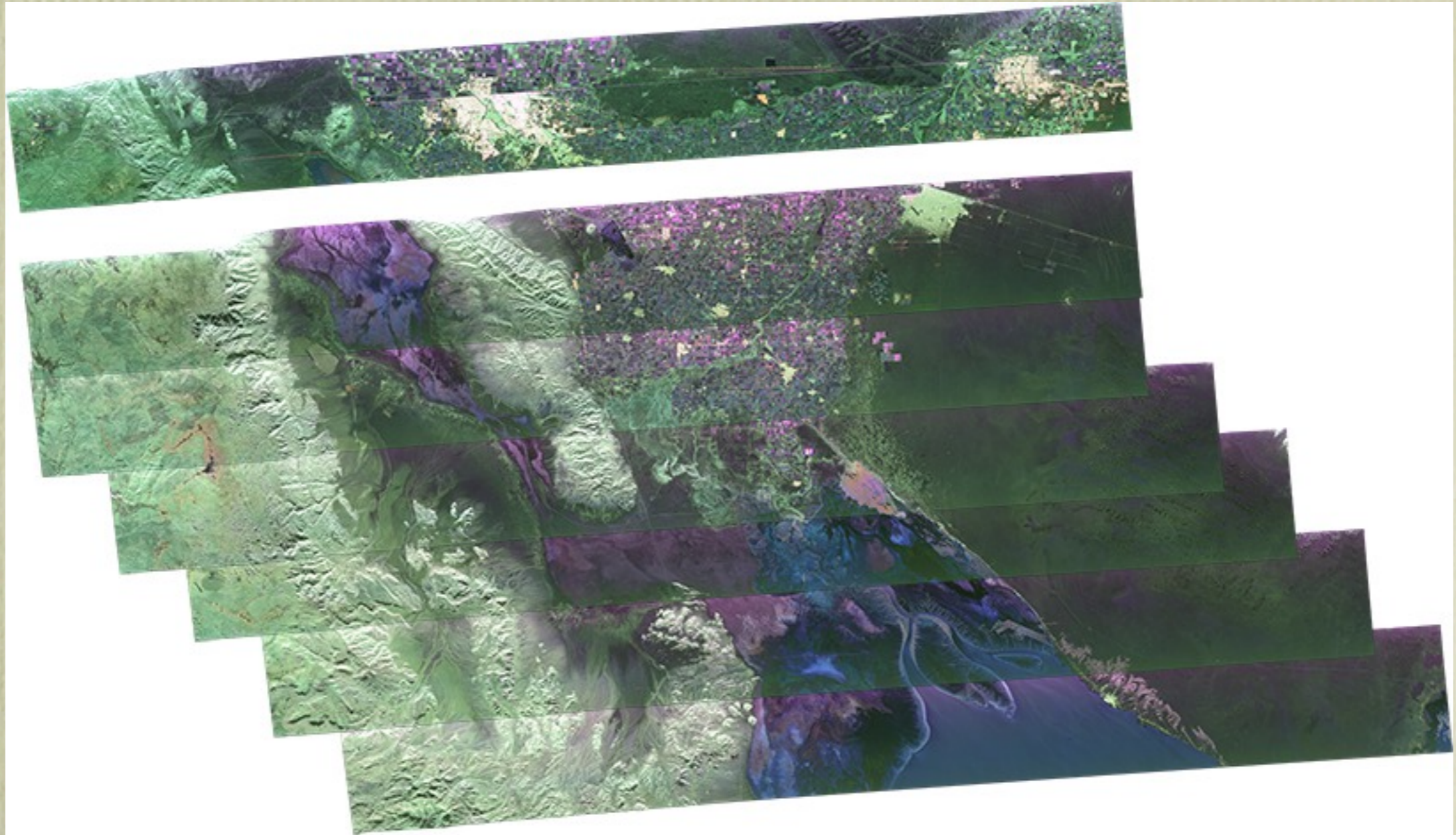


Salton Trough, Mexico

- 18 flight lines (2 flights)
- flown 4 times/year
- red lines 2010 M 7.2 earthquake surface ruptures, star epicenter
- black rectangles fault model of *Wei, Fielding, et al. (2011)*
- blue line Colorado River

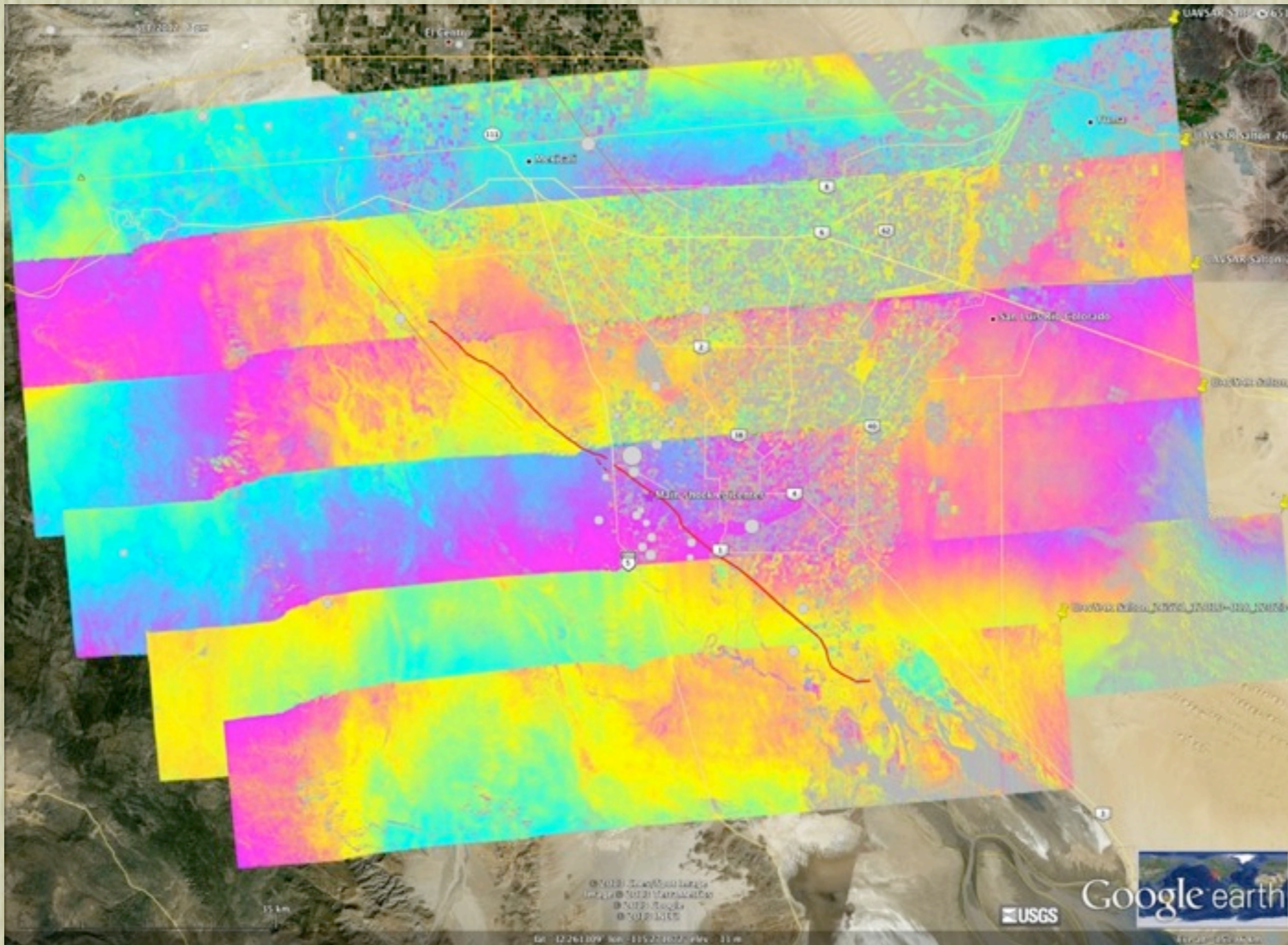


Mexico PolSAR mosaic



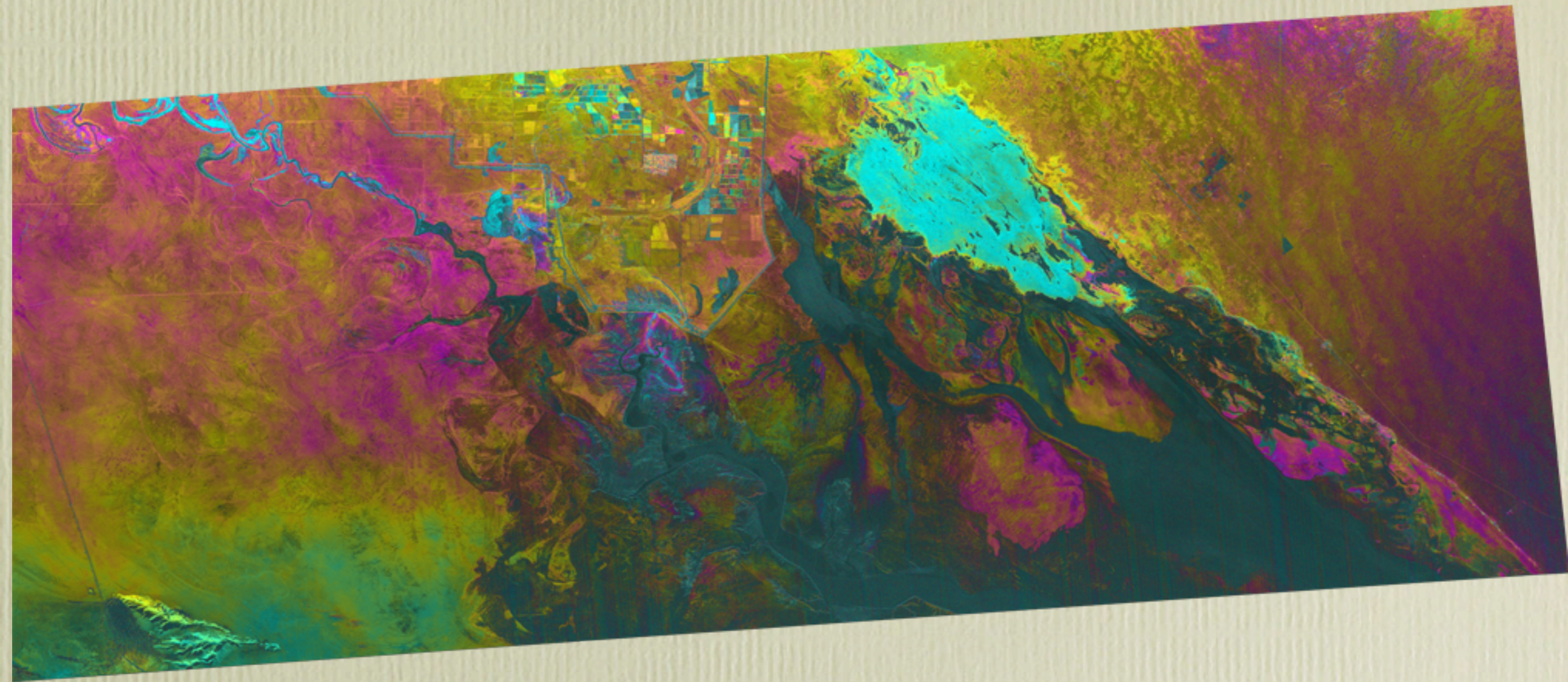
- February 1-3, 2012
- Flight lines 26511-26525
- HH red, HV green, VV blue
- Baja California & Sonora

Feb.–May 2012 RPI mosaic



- Wrapped RPI's
- Flight lines 26511–26521
- Phase mostly water vapor, surface water

Feb.–May 2012 RPI detail



- Flight line 26521
- Lower Colorado River Delta
- Neap tide flights

- Tidal flooding-wet mud incoherent
- Cienega de Santa Clara water level change

Conclusions

- Patiently waiting for more RPI products
- Stack processor could be major advantage for time series analysis, especially if co-registered SLC images available for analysis
- New software to geocode the slant-range data big help for analysis
- 3D vector motion software release will also enable more advanced analysis