



National Institute of  
Advanced Industrial Science  
and Technology  
**AIST**

2008/01/15

DPRI, Kyoto Univ.

# ***Deformation in the Long Valley caldera, eastern California***

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*Geological Survey of Japan, AIST*

# *Acknowledgements*

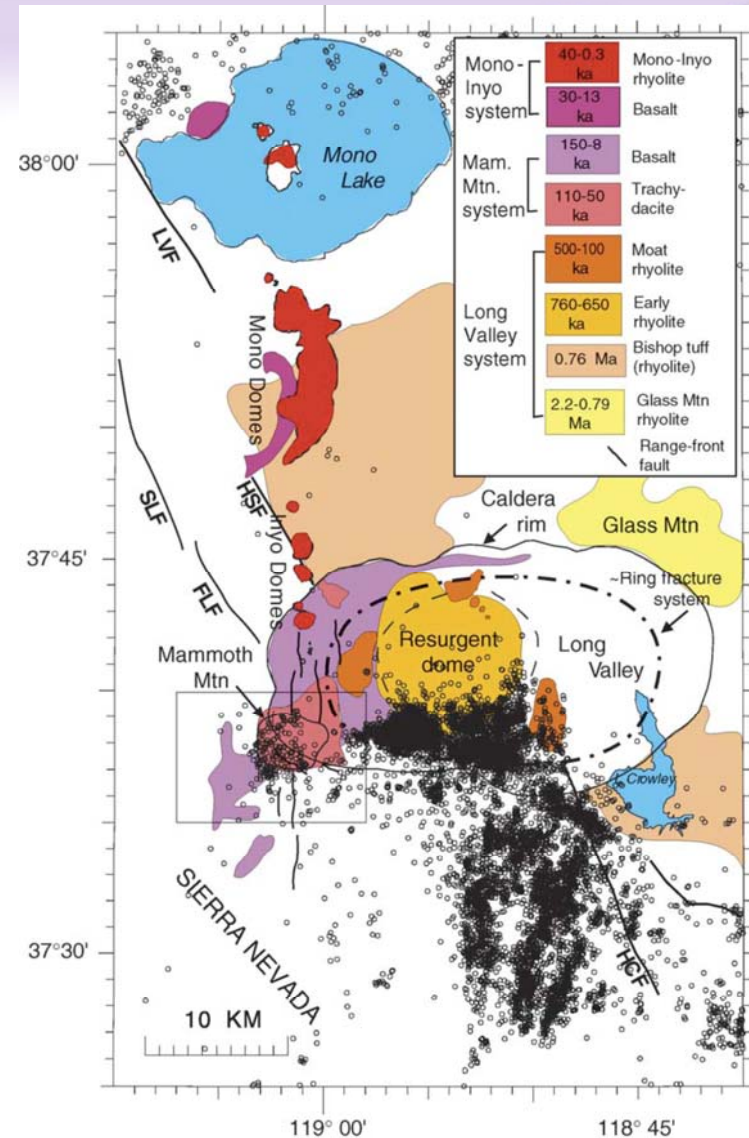
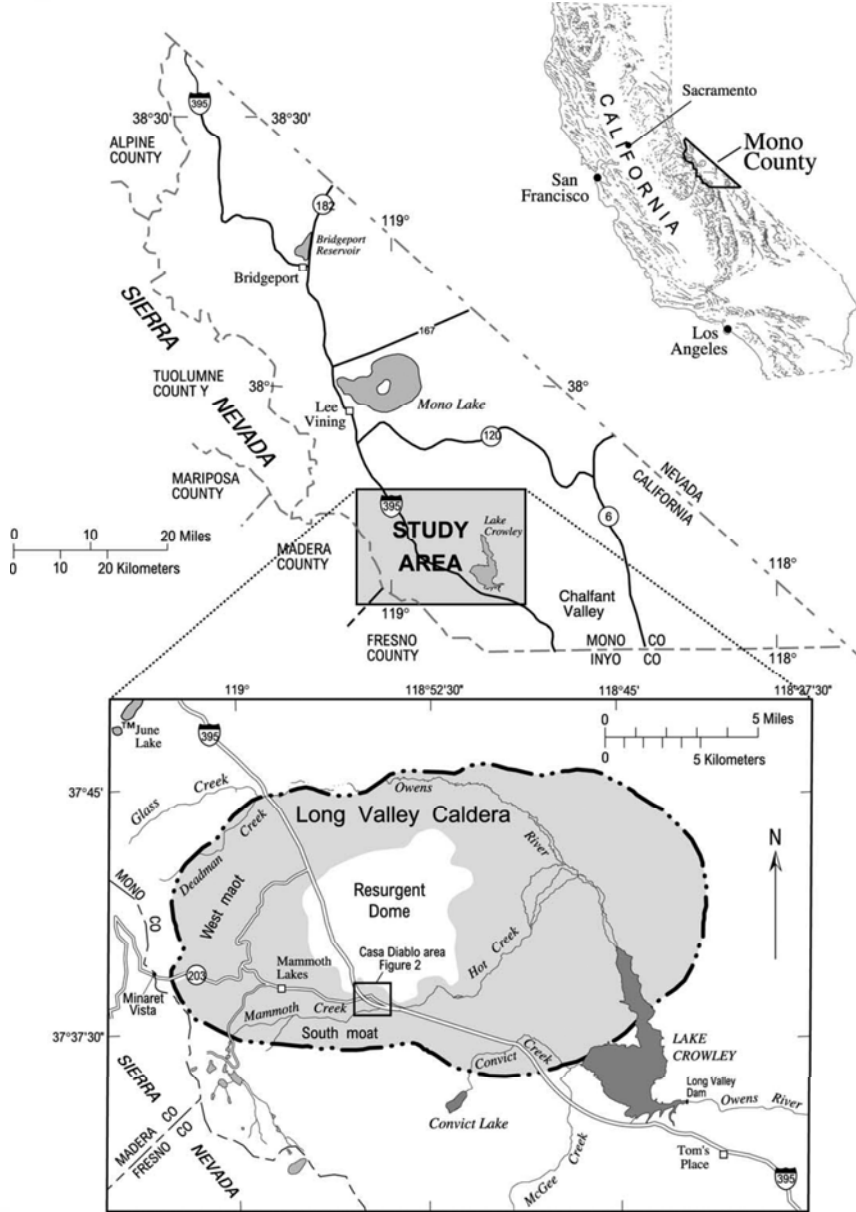


PIXEL (PALSAR Interferometry Consortium to Study our Evolving Land surface)

ERSDAC (Earth Remote Sensing Data Analysis Center)

The ownership of PALSAR data belongs to METI and JAXA.

# Map of Long Valley Caldera



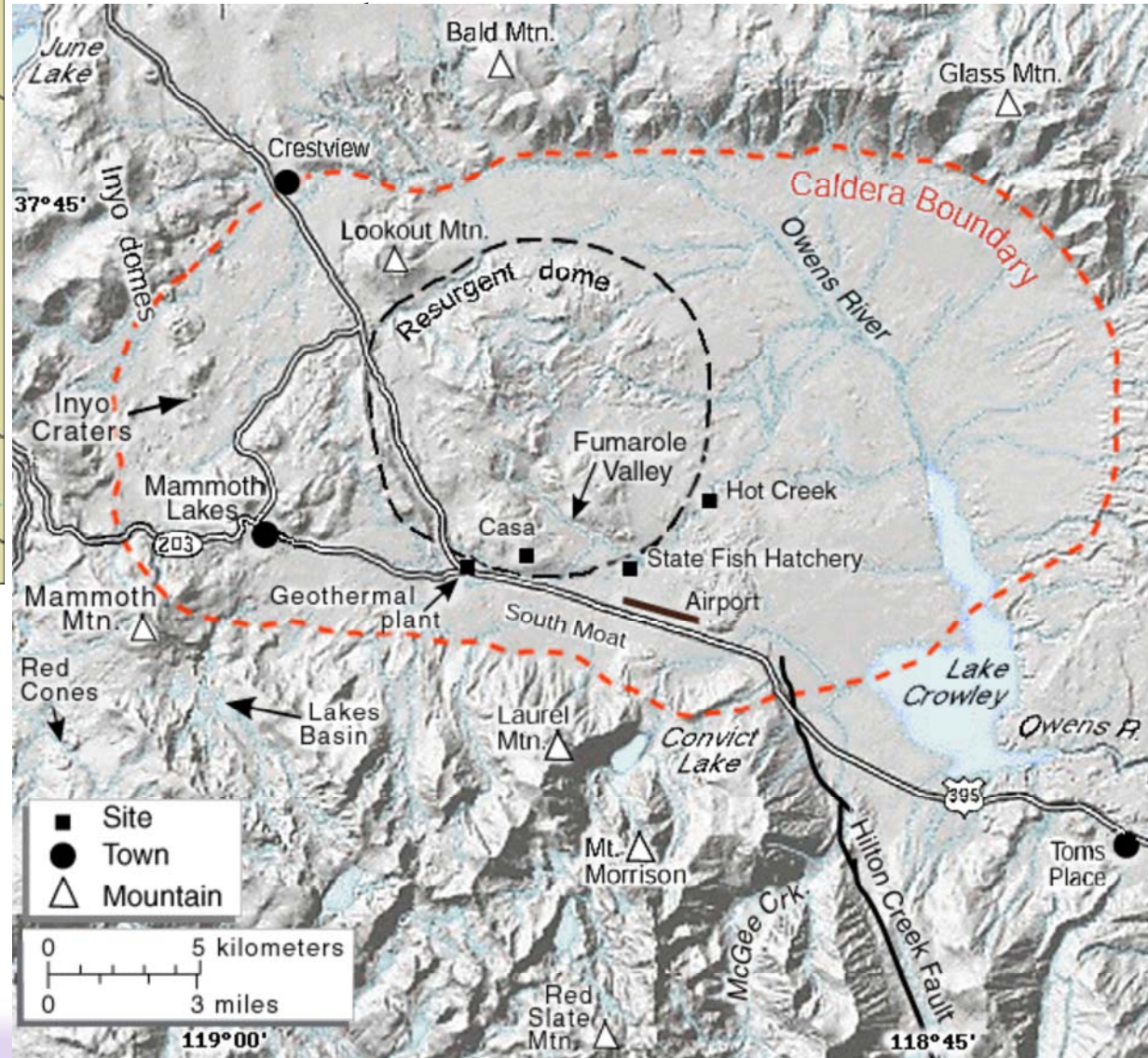
Generalized geologic map of the Long Valley Caldera-Mono Lake region showing the distribution of principal volcanic units erupted in the past 2 million years together with major normal faults and epicenters of  $M \geq 1.2$  earthquakes from 1978 through 2003. [Hill and Prejean, 2005]

[Howle *et al.*, 2003]

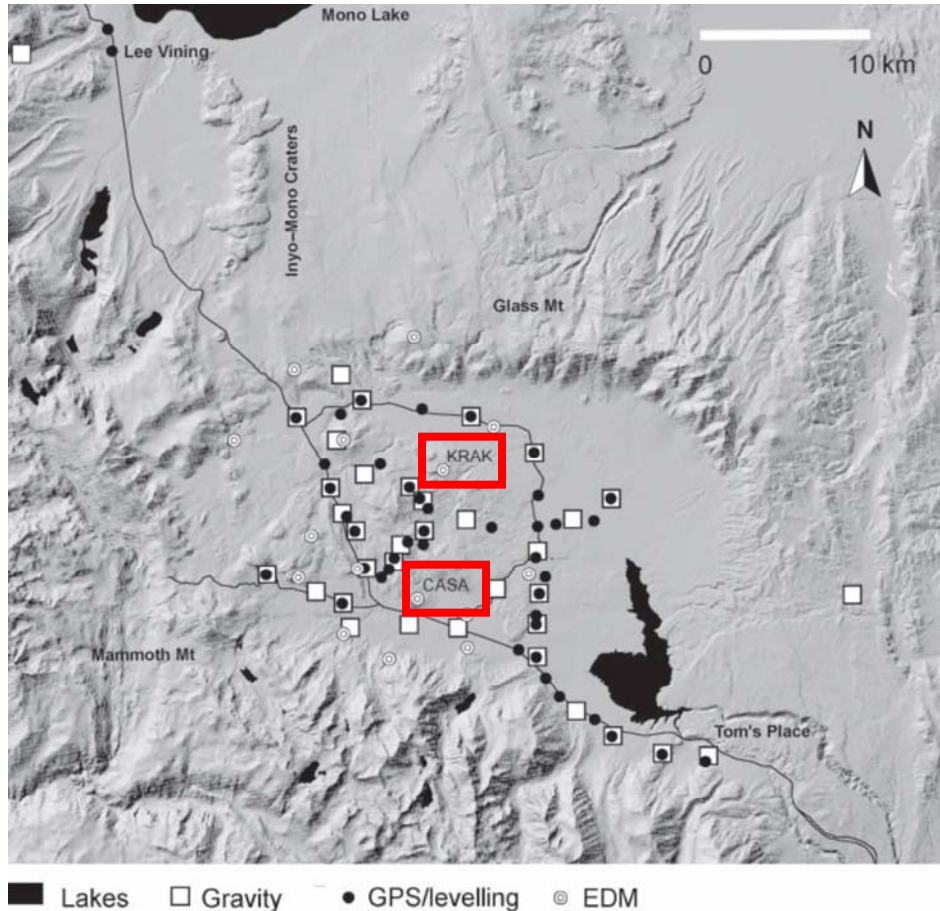
# General Location Map of the Long Valley area



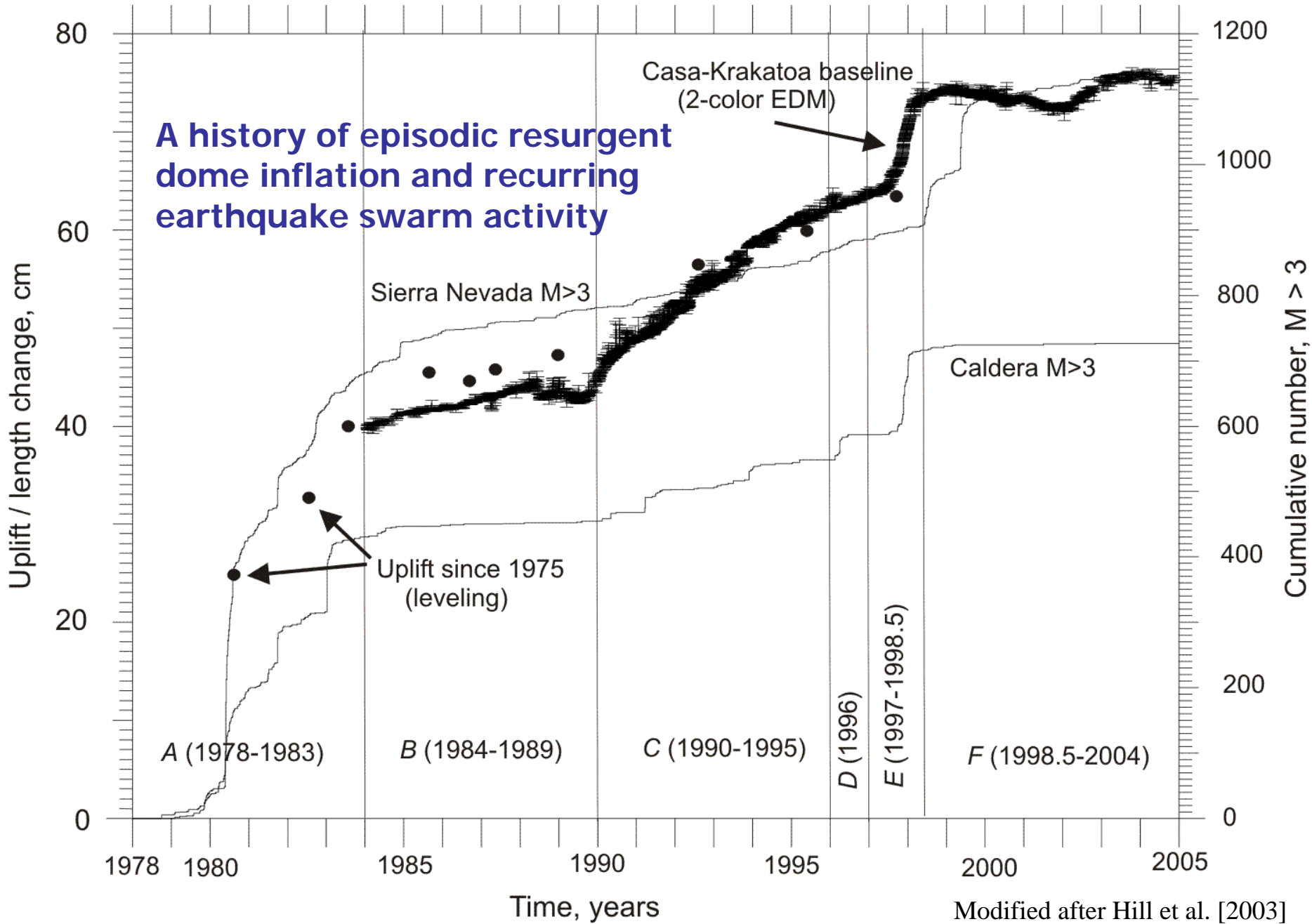
<http://lvo.wr.usgs.gov/gallery/MapGallery.htm>



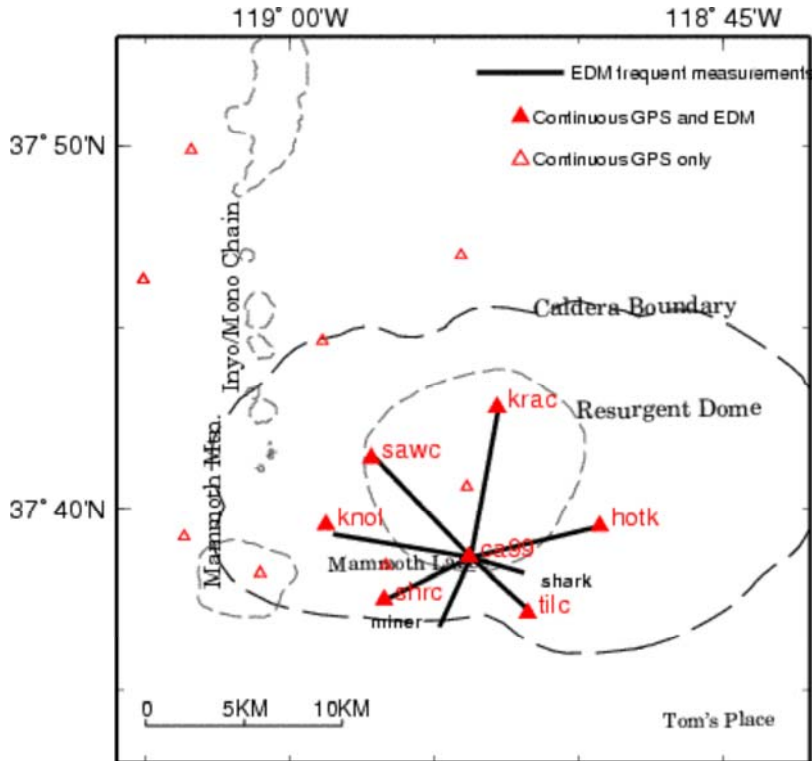
# Map of Long Valley Caldera



The resurgent dome is the broad, dome-shaped highland of post-caldera lava domes about 9 km in diameter that stands at the centre of the caldera, about 500 m above the surrounding lowlands that form the caldera 'moat'. Mammoth Mountain is a cumulo-volcano formed by repeated eruptions of dacite and rhyodacite from vents on the southwest rim of the caldera 220 000 - 50 000 years ago (Hildreth, 2004). The map shows the levelling routes, the two-colour EDM geodetic network, the levelling sites occupied with GPS, and the gravity network. [Battaglia and Vasco, 2006]

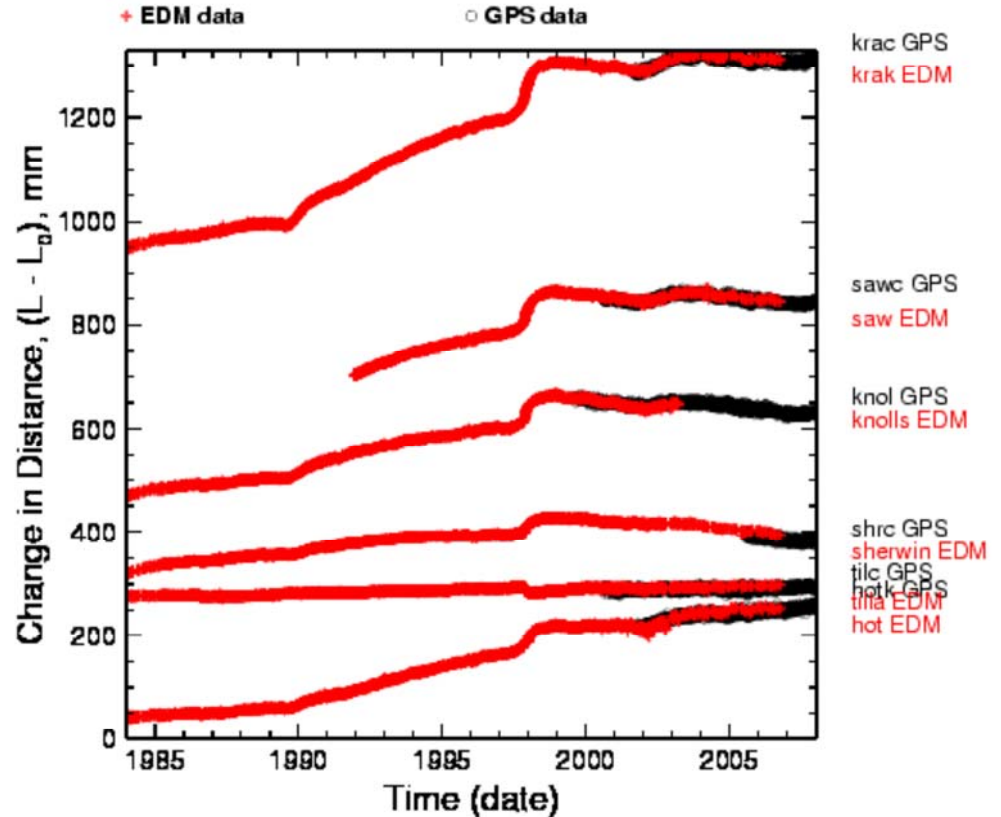


# Changes in Distances



## Measurements since Sept 1984

EDM and GPS baseline length changes from CASA



These data are preliminary and should be used with caution; John Langbein, USGS

Updated: Mon Jan 7 16:13:29 PST 2008

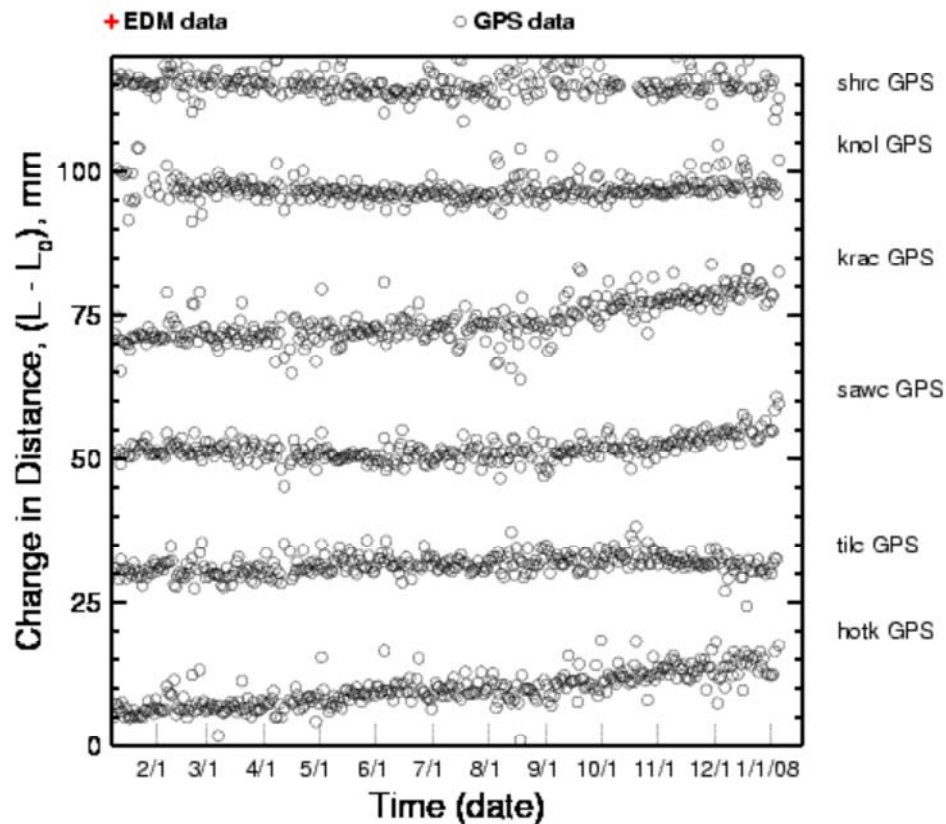
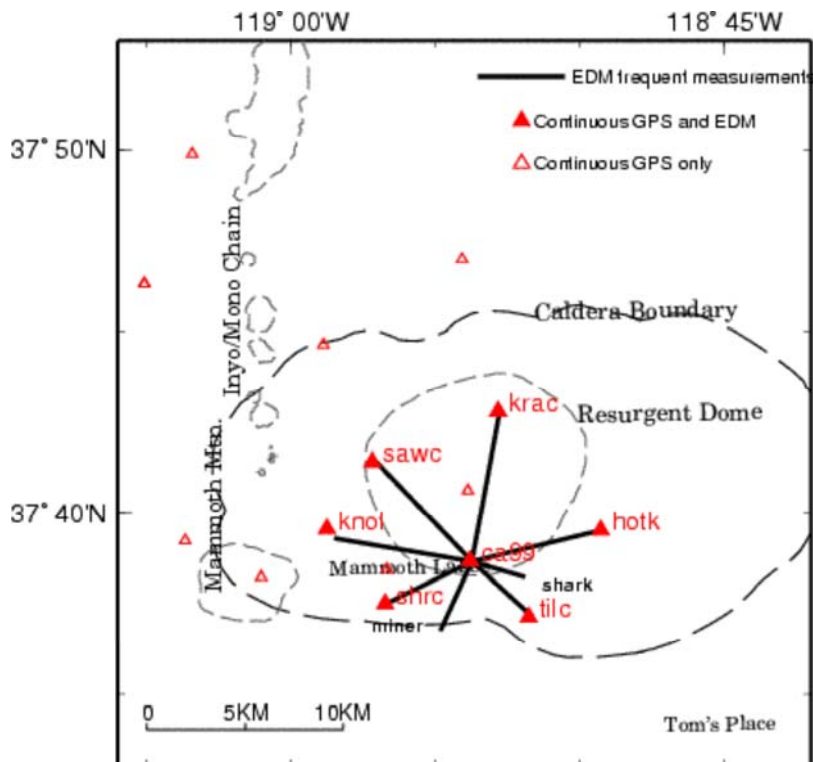
Locations of baselines being measured with the two-color EDM and continuous GPS stations. For six baselines, the GPS data can be converted to length-changes and directly compared with those length changes measured by the two-color EDM.

***We have stopped using the two-color EDM in favor of continuous GPS!***

# Changes in Distances

## Measurements from the past year

### EDM and GPS baseline length changes from CASA



*These data are preliminary and should be used with caution; John Langbein, USGS*

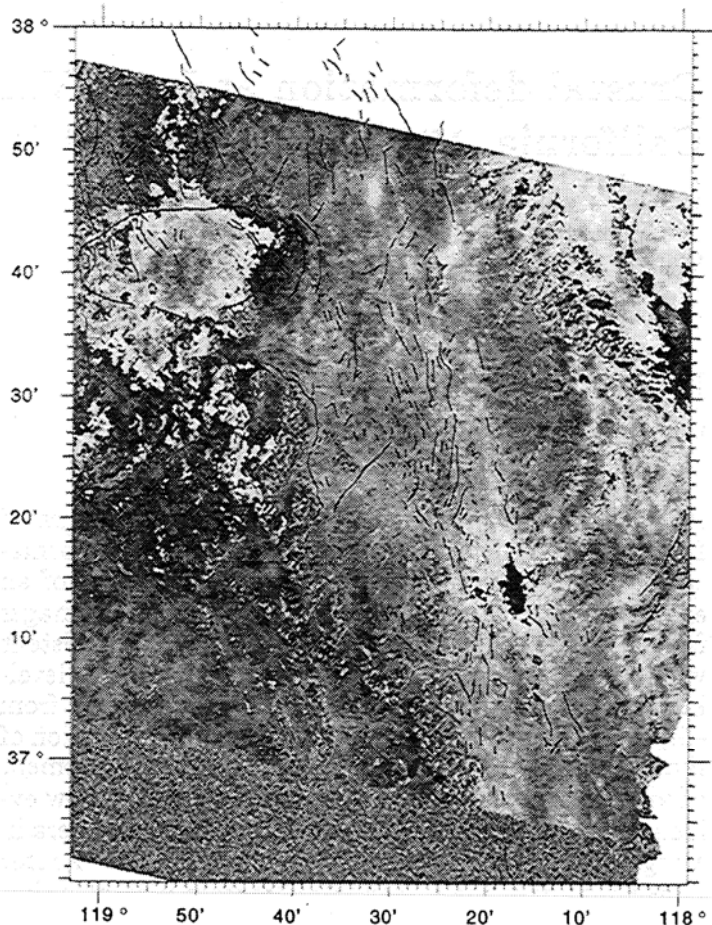
*Updated: Mon Jan 7 16:11:07 PST 2008*

*Note--There are NO EDM data in this interval*

Locations of baselines being measured with the two-color EDM and continuous GPS stations. For six baselines, the GPS data can be converted to length-changes and directly compared with those length changes measured by the two-color EDM.

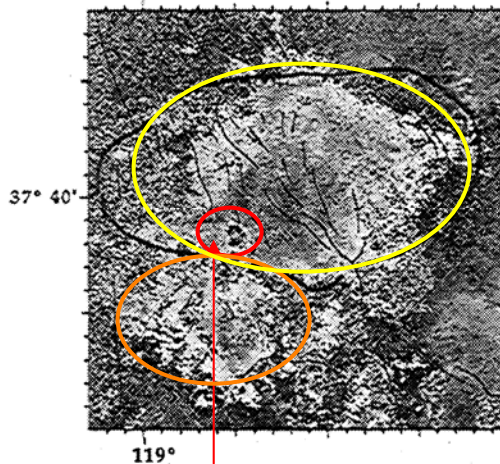


# Inflating Resurgent Dome from 1992-1996 (ERS-1)



July 1993-May1995

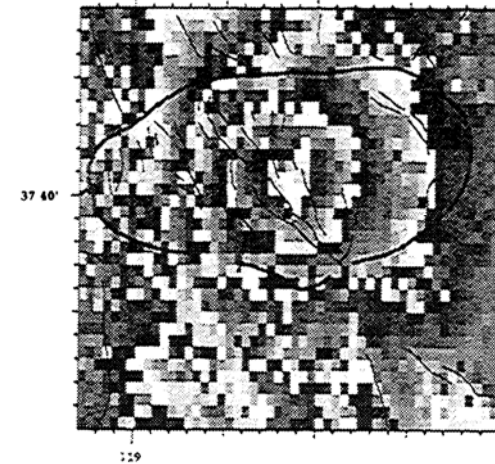
a. 04 July 1993-23 May 1995 Interferogram



Casa Diablo Geothermal Field

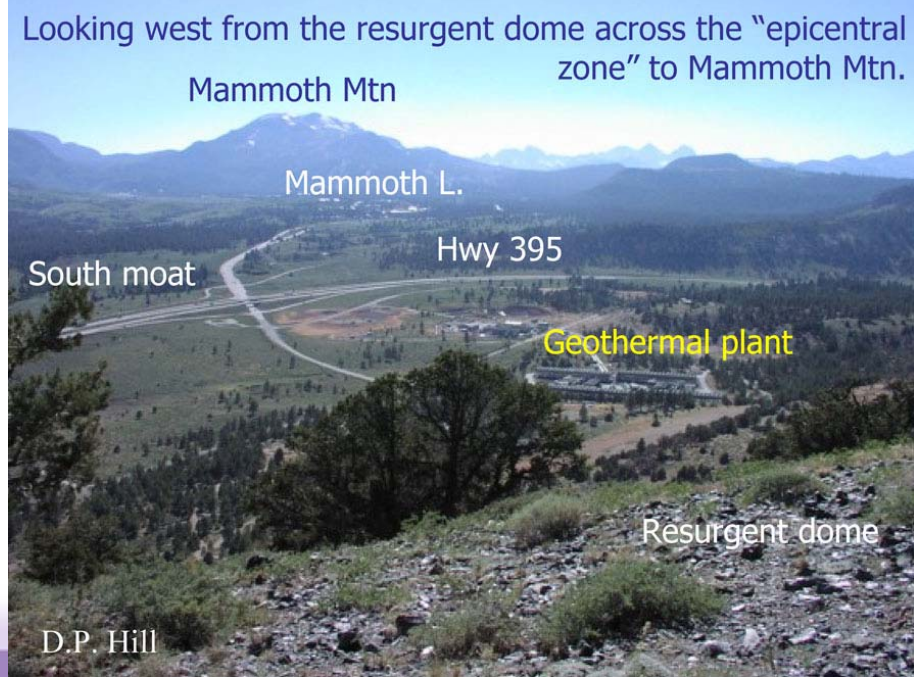
July 1992-May1996

a. 25 July 1992-13 May 1996 Interferogram

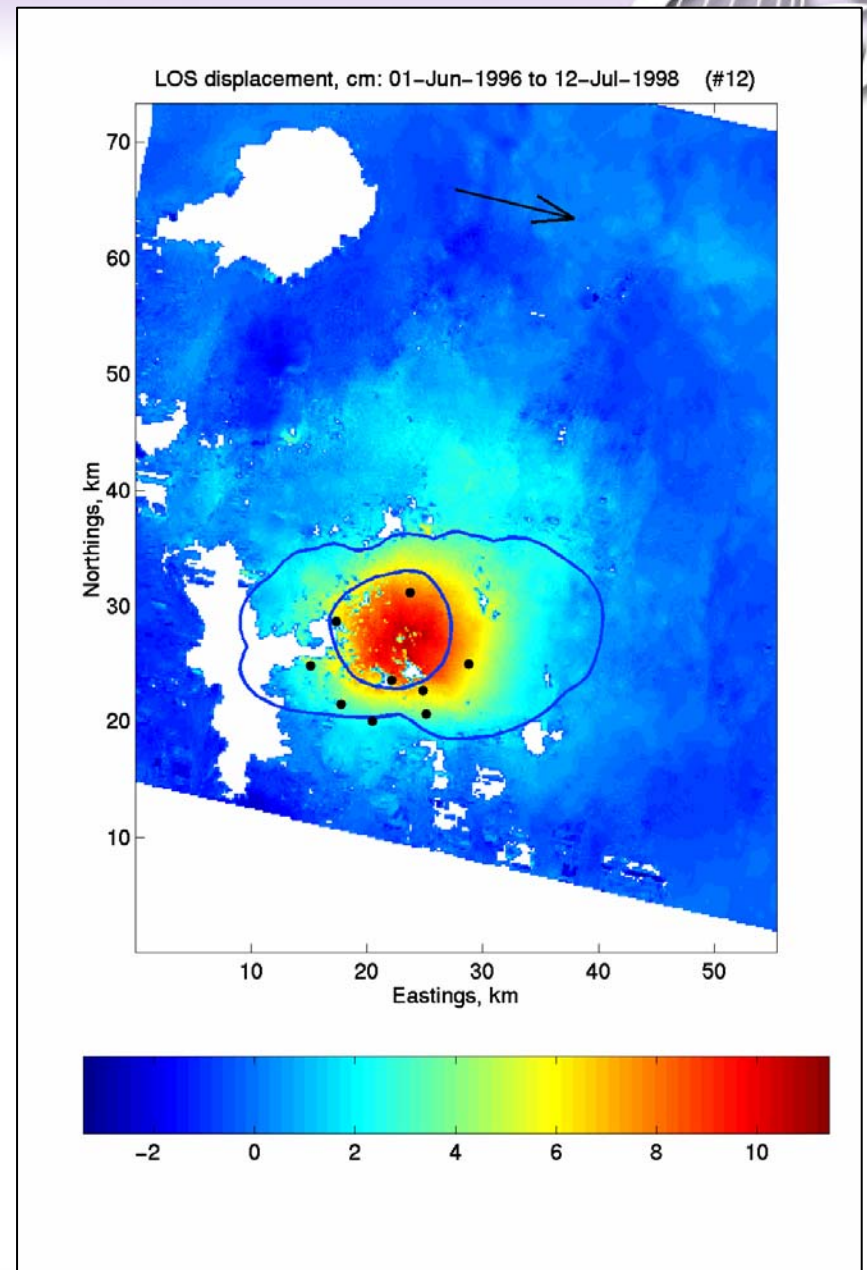
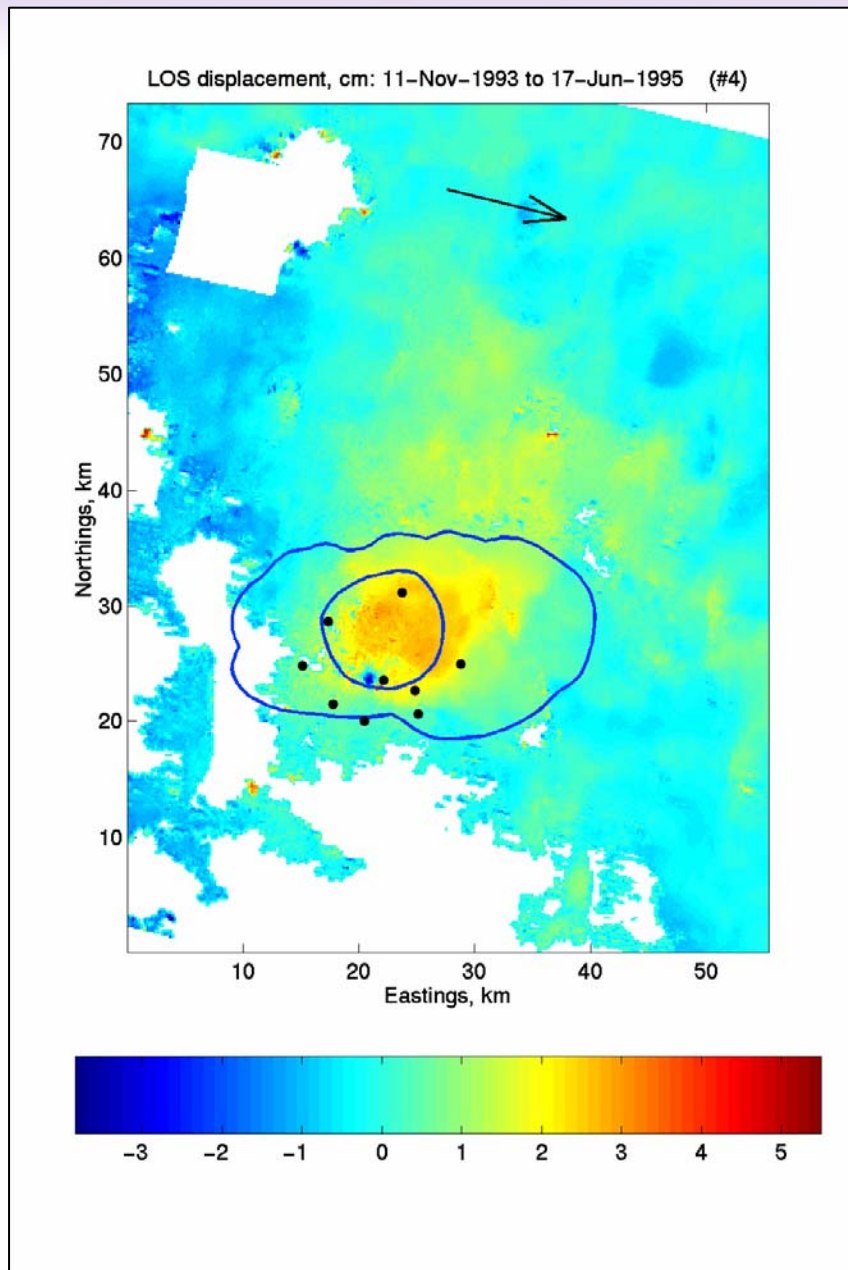


~ 5 cm Inflation and Deflation

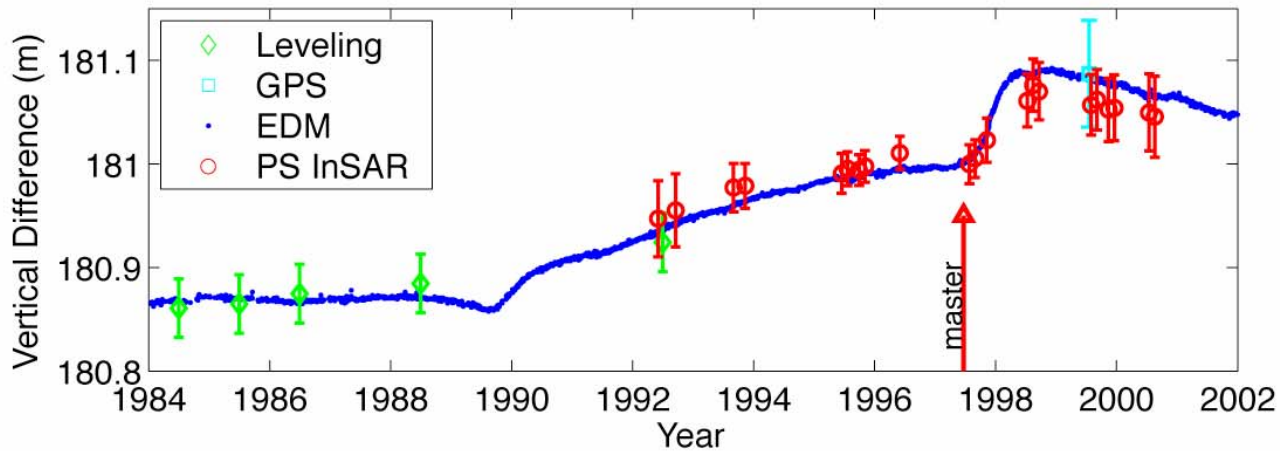
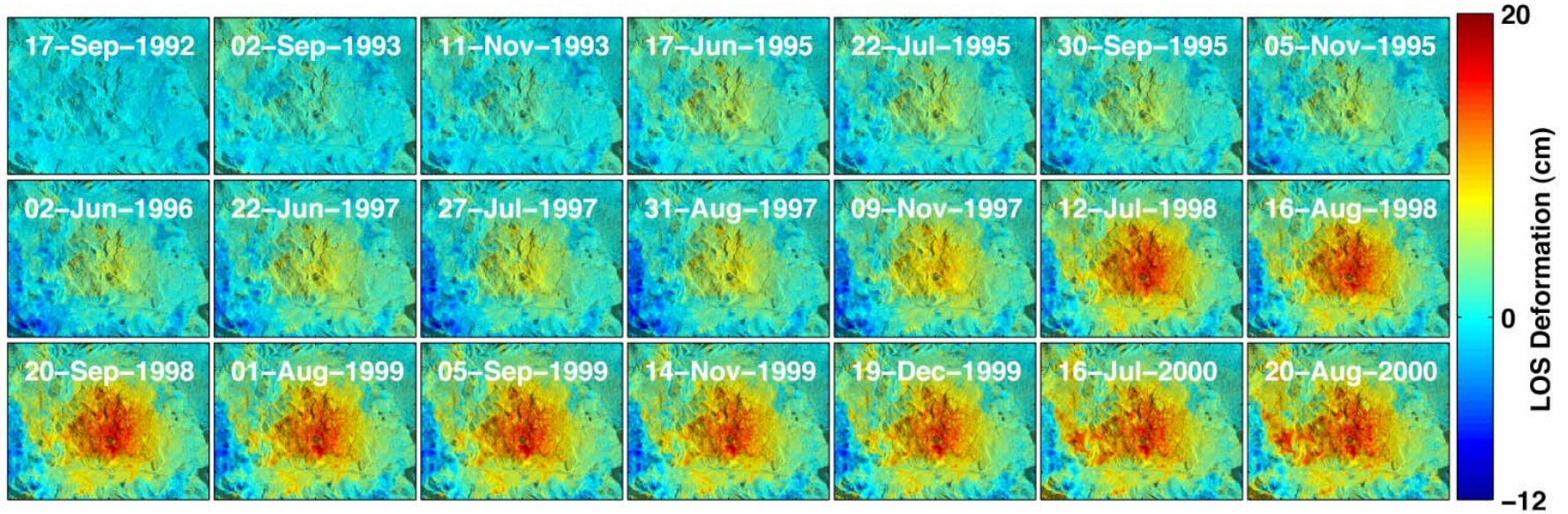
Thatcher and Massonnet [1997]



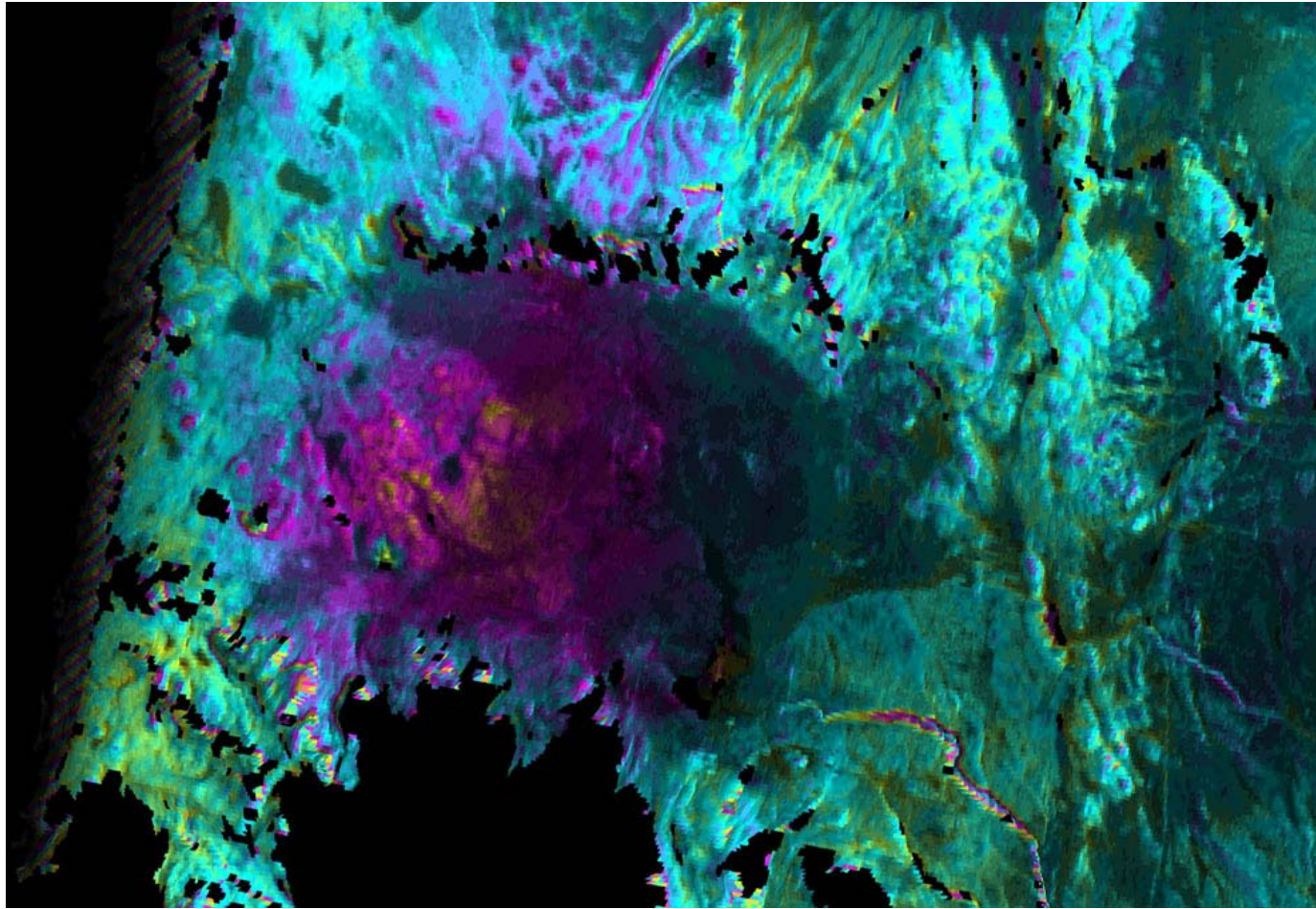
# Inflating Resurgent Dome from 1996-1998: a Growing Blister in the Caldera



# Deformation in Long Valley Caldera using Persistent scatterer analysis: PS versus leveling and GPS



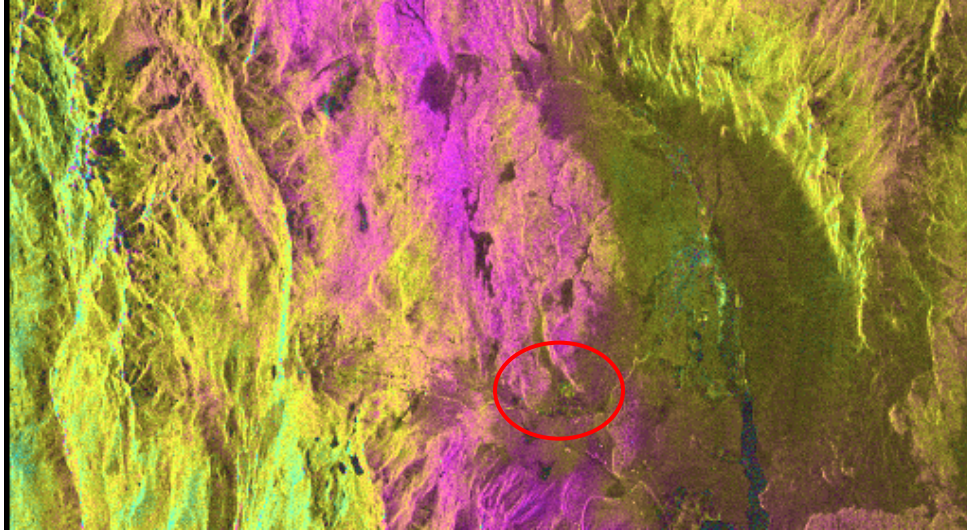
[Hooper and Zebker, 2007]



- ROI\_PAC
- DEM (NASA/JPL airborne SAR)

~ 5 cm Inflation and  
Deflation at Casa Diablo  
geothermal field

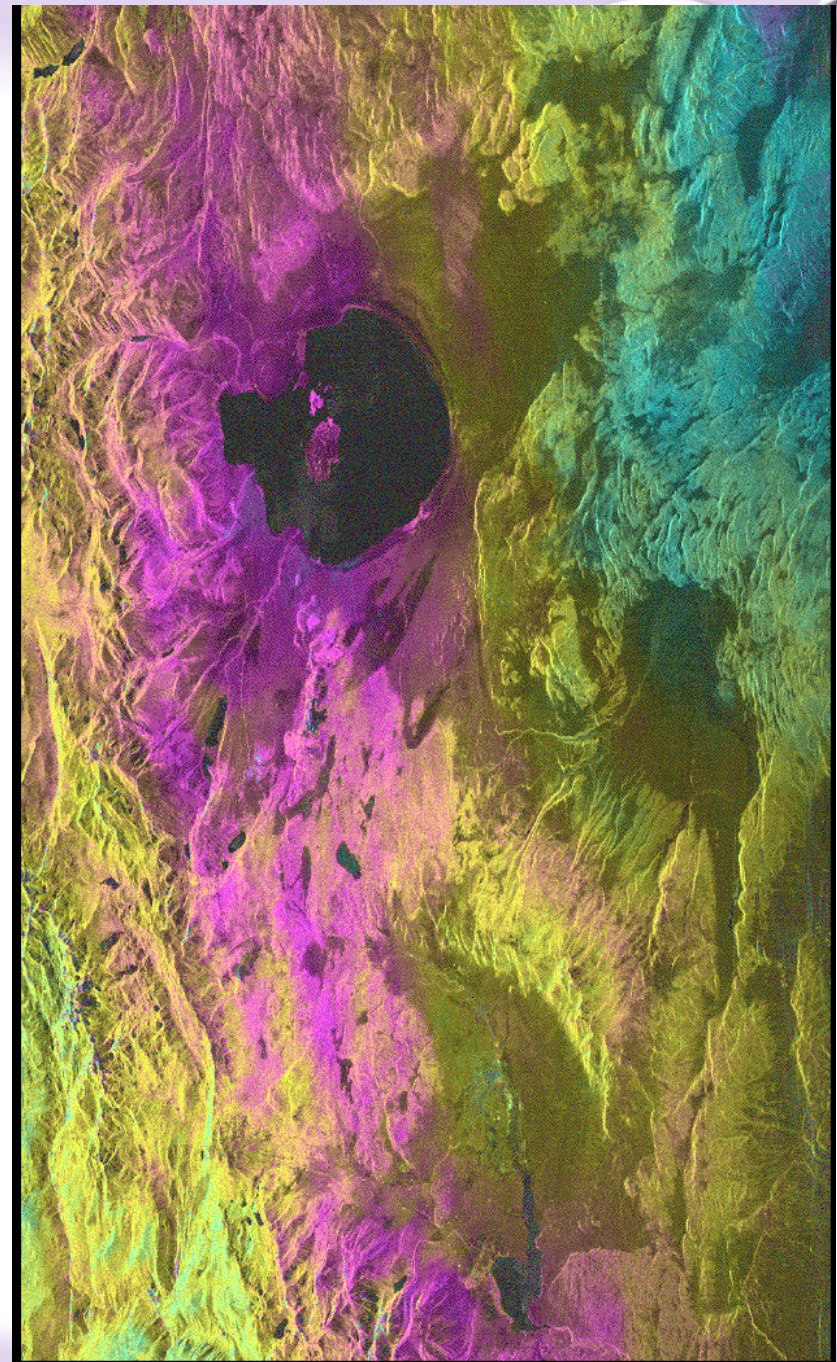
070703-070818 (PALSAR)  
75/216 FBDH



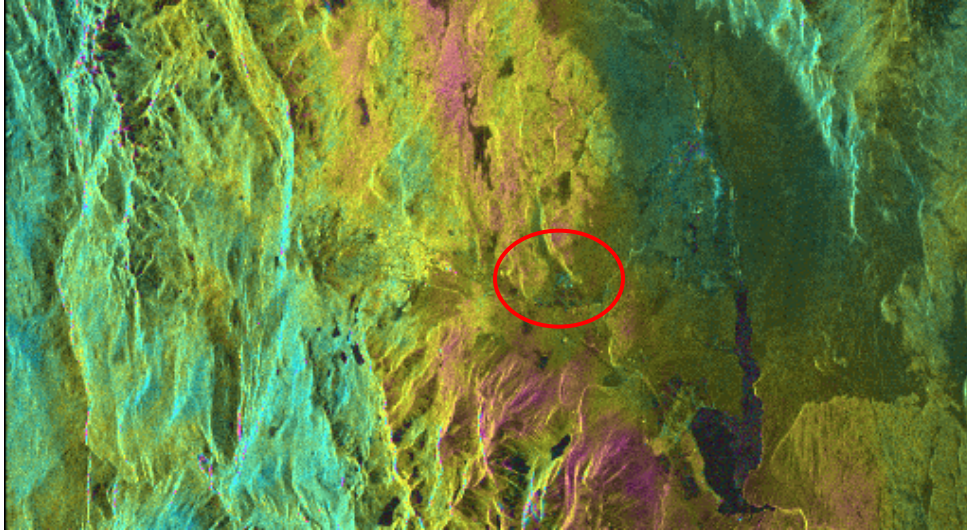
SRTM DEM

$B_{\text{perp.}} \sim 220 \text{ m}$

Deflation at Casa Diablo geothermal field

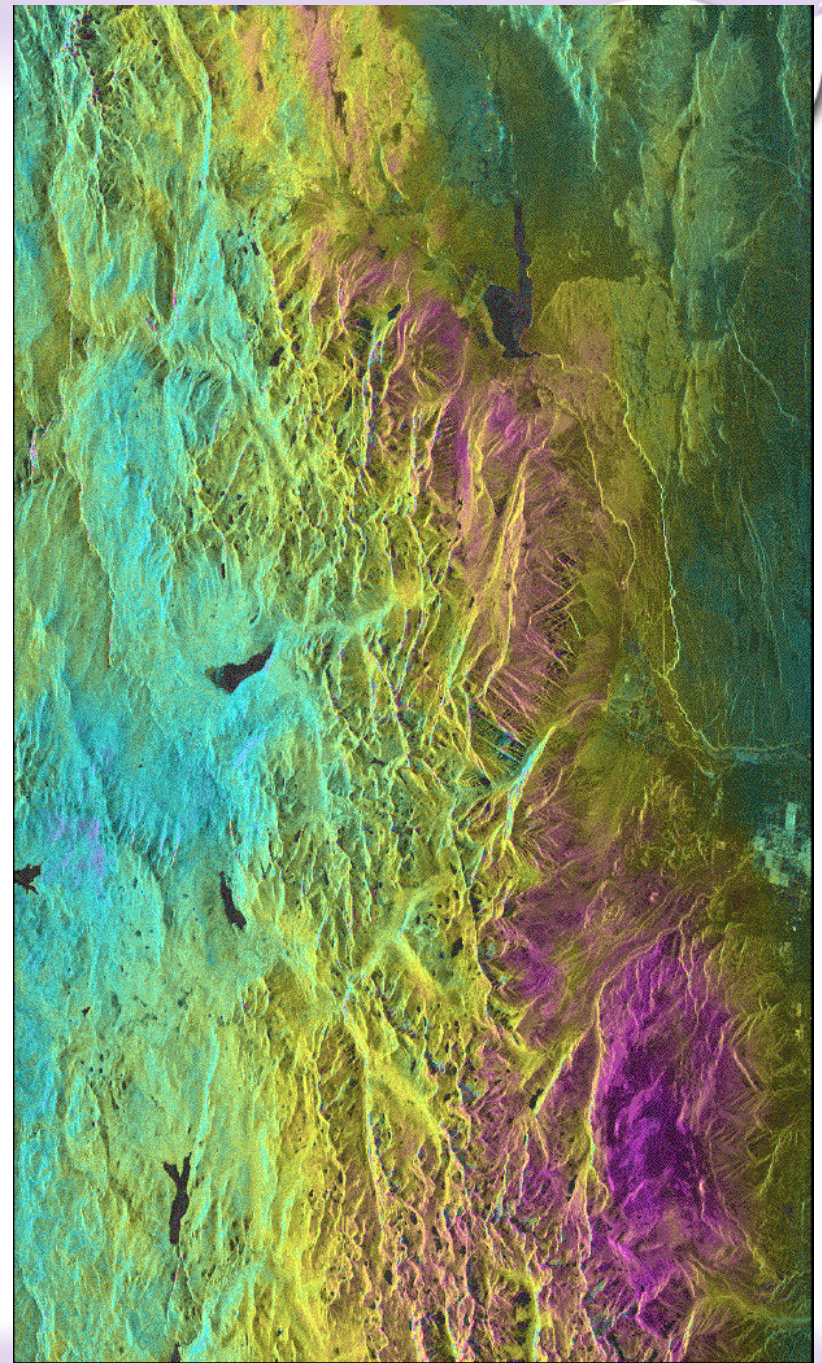


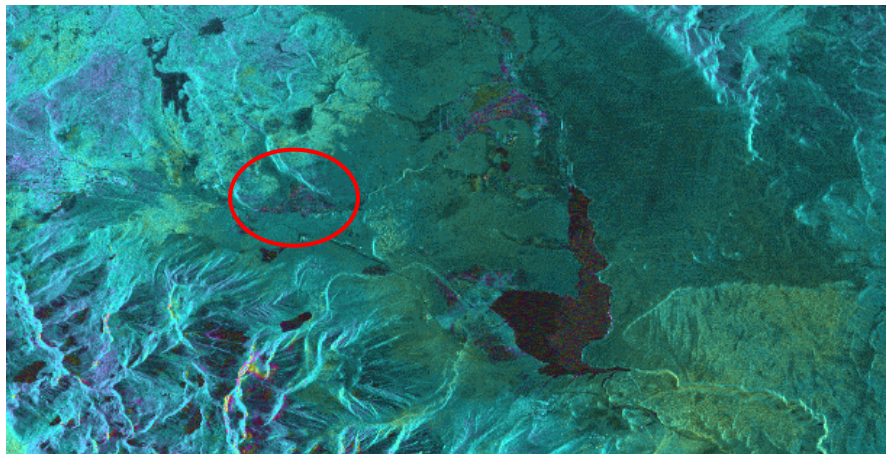
070703-070818 (PALSAR)  
74/216 FBDH



$B_{\text{perp.}} \sim 220 \text{ m}$

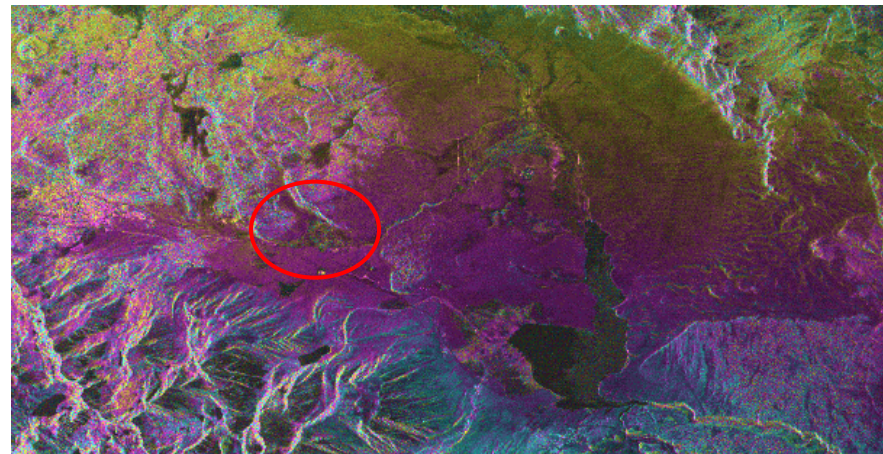
Deflation at Casa Diablo geothermal field ?





***060815-0711 (PALSAR)***  
***74/216 FBSH***

$B_{\text{perp.}} > 2000 \text{ m}$



***060815-060930 (PALSAR)***  
***74/216 FBSH***

$B_{\text{perp.}} \sim -220 \text{ m}$

# *Conclusions*



- JERS-1 interferogram (June 1993-August 1998) shows a small region of subsidence associated the Casa Diablo geothermal power plant, which is superimposed on a broad scale uplift/expansion of the resurgent dome.
- PALSAR interferograms show no deformation of the resurgent dome as expected. However, it may show a small region of subsidence associated the Casa Diablo geothermal power plant.



# *Future Directions?: Dedicated and Planetary*



Satellites to date have not been optimized for InSAR.

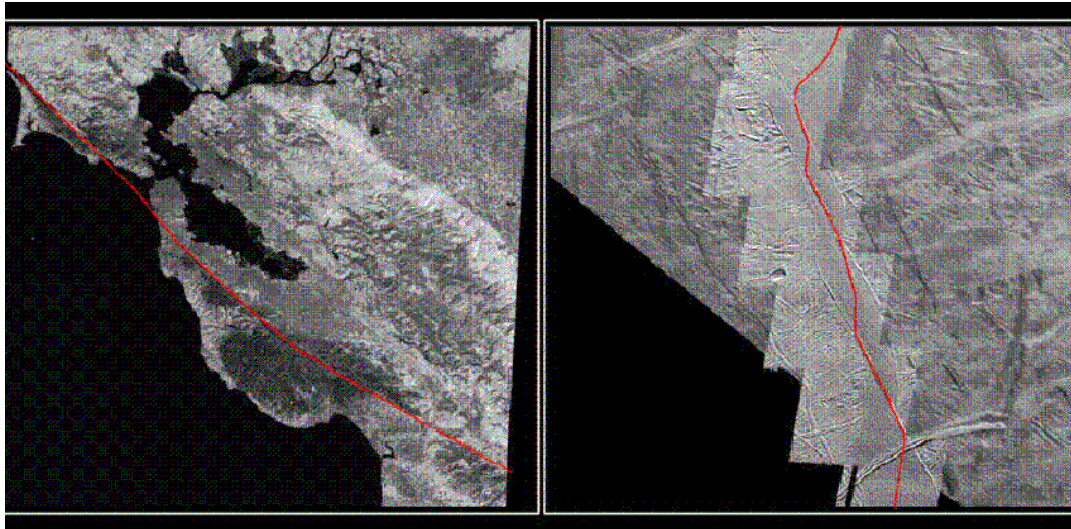
- A dedicated satellite able to make frequent and consistent observations.
- Constellations of InSAR satellites in a variety of orbits allow near-real-time imaging.

-> Shimada-san and/or Kodama-san.

# Future Directions?: Dedicated and Planetary

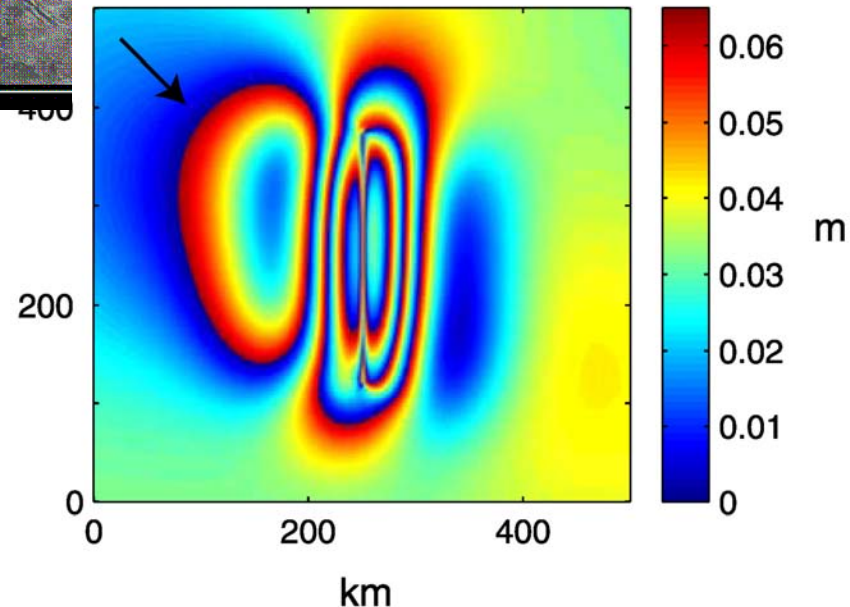


InSAR missions to Venus, Mars, Europa, or Titan could potentially reveal various deformational processes.



Synthetic interferogram of tidal strain at crack on Europa (Possible Design for Europa SAR: S-band (13 cm), 1000 km orbit) [Sandwell *et al.*, 2004]

critical baseline ~20 km  
Orbital control ~ 5000m  
R



Galileo high-resolution image of a strike-slip region on Europa, compared with the San Andreas Fault at the same scale. Images are about 200km across.

[<http://es.ucsc.edu/~fnimmo/website/images.html>]