

Megan Ani Mirkhanian  
UC Irvine/SCEC

Lisa Grant Ludwig  
UC Irvine

Andrea Donnellan, Jay W. Parker, & Robert A. Granat  
Jet Propulsion Laboratory, California Institute of Technology

## ABSTRACT

GeoGateway (<http://geo-gateway.org>) is a web map-based science gateway supported by NASA's ACCESS program. A goal of GeoGateway is to expand the utility of NASA's geodetic imaging data products by making them easy to access, analyze, and interpret. The objective of this project is to use GeoGateway to explore tectonic deformation associated with recent seismic activity in the Cajon Pass region. The area can be investigated using the Line-of-Sight (LOS) tool which allows us to easily select UAVSAR (Uninhabited Aerial Vehicle Synthetic Aperture Radar) Interferometry data and Global Positioning Satellite (GPS) data via GeoGateway.

The Cajon Pass, a fault junction between the San Andreas Fault System (SAFS) and San Jacinto Fault Zone (SJFZ), contains many critical lifeline facilities, and is bounded by the San Bernardino and San Gabriel mountain ranges in southern California. The Cajon Pass is being investigated as a possible "Earthquake Gate", where areas of fault complexity halt earthquake ruptures depending on if the gate is "opened" or "closed." Identification of interseismic strain accumulation and co-seismic slip on faults near Cajon Pass is important for understanding fault system behavior and mitigating damage from earthquakes. We used GeoGateway to search for deformation associated with the 29 December 2015 Mw4.4 Devore earthquake (epicenter 34.191°N 117.413°W) which occurred at depth of ~7.0 km on the SJF, to assess if such deformation can be identified. Using LOS tool for UAVSAR interferometric data display, we found measurable change, but the anthropogenic and hydrologic signals appears to be larger than the tectonic signal, making it difficult to identify tectonic deformation. However, there might be a slight persistent uplift of about 1 mm a year in the Cajon Pass. An elastic forward model of the earthquake shows that the event is too small and far from the Cajon Pass to produce measurable surface deformation, however the observed regional uplift deformation and the occurrence of the earthquake may be reflective of the state of stress of the crust in that region and long-term tectonic motion.

## GEOGATEWAY

The purpose of GeoGateway is to Increase the value of existing geodetic imaging products to researchers and allow users to efficiently find and use NASA geodetic imaging data products

### Goals

- Bridge the gap between production and end-use of data products
- Simplify discovery of geodetic imaging products
- Enable researchers to explore and integrate data products
- Allow researchers to easily share, publish, and collaborate

## GEOGATEWAY DATA FUSION

We use NASA's GeoGateway tool to access, analyze and model GPS and UAVSAR data along the SAFS and SJFZ in the Cajon Pass, and incorporate optical imagery, fault models, and paleoseismic data from geologic studies. GeoGateway is a convenient and powerful tool for analyzing heterogeneous data sets.

### Crustal deformation data

- GPS position time series and velocities
- InSAR/UAVSAR interferograms
- Optical maps
- Topography

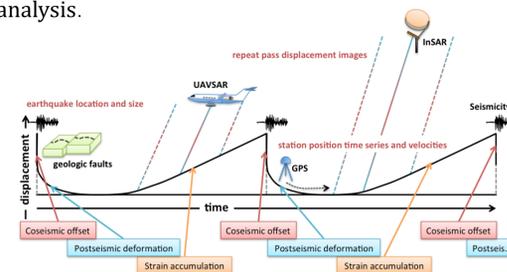
### Other geophysical data

- Earthquakes
- Faults & paleoseismic data



## CRUSTAL DEFORMATION

Crustal deformation is spatially and temporally non-uniform as strain accumulates over long time scales, is rapidly released in earthquakes, and readjusts post-seismically. Multiple types of data from different parts of the earthquake cycle are required for analysis.

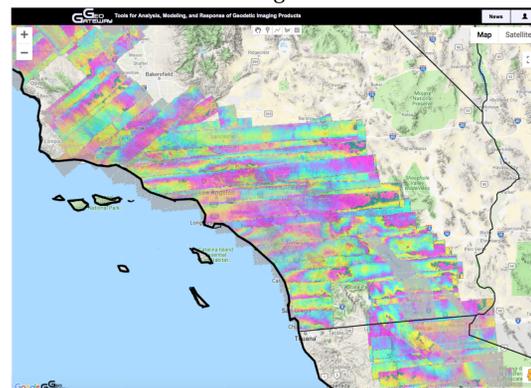


## LINE-OF-SIGHT (LOS) TOOL

- GeoGateway's Line-of-Sight (LOS) tool allows easy selection and plotting of interferograms from pairs of UAVSAR flights.
- The interferogram images allow change detection for recognition of tectonic deformation.
- The LOS tool measures and displays surface elevation changes during the time period between flights.
- This is helpful for detecting creep, interpreting results of paleoseismic studies, and recognizing interseismic deformation.

## UAVSAR/INSAR INTERFEROGRAMS

GeoGateway allows users to efficiently find and use NASA geodetic imaging data products. Here we see available UAVSAR interferograms spanning the San Andreas fault in the Cajon Pass, and surrounding areas, overlain by traces of UCERF3 faults. Users can zoom in and select relevant images.

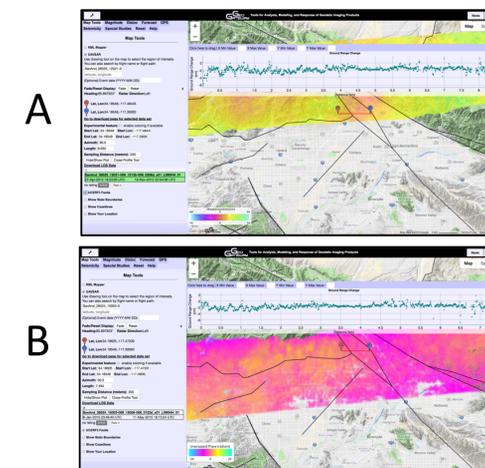


## GLOBAL POSITIONING SYSTEM (GPS) TOOL

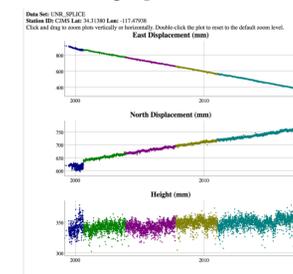
GeoGateway's GPS tool allows for measuring plate motion and strain accumulation across faults. The data is gathered when the GPS station communicates with satellites. The movement is seen within Geogateway's three graphs, with the y-axis labeled as East and North displacement and Height in mm, and the x-axis labeled as time in years. The dots represent the data points, recorded almost every day.

## IMAGING CREEP & OFF-FAULT DEFORMATION

The LOS tool (red line), used as a tool to identify creeping along a fault, shows that there is no discernible creep across the area of the Devore earthquake near the SJFZ in both figure A and B.

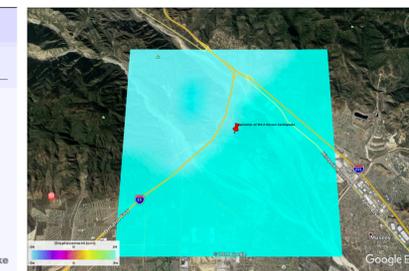


Using the GPS tool, the graphs display the movement of the GPS station selected. The graphs show that the GPS station (CJMS) is moving Northwest and has a slight upward change in height. Within the first graph, the dots are moving West, and in the second graph the dots are moving North.



After completing an elastic forward model of the Devore earthquake, the model shows that the event is too small and far from the Cajon Pass to produce measurable surface deformation, as we see that there is no change in displacement.

Map Tools	Magnitude	Disloc	Forecast	GPS
Seismicity	Special Studies	Reset	Help	
<b>Moment Magnitude Calculator</b>				
Length:	1	km		
Width:	1	km		
Slip:	.15	m		
Shear Modulus:	3	10 <sup>11</sup> dyne/cm <sup>2</sup>		
<b>Calculate</b>				
Seismic Moment:		4.5E+22		
Moment Magnitude:		4.4		
Default values are approximate for 2011 M 9.0 Tohoku-Oki earthquake				



In conclusion the Cajon Pass, a possible earthquake gate, shows no deformation associated with the 2015 Mw4.4 Devore earthquake although there is a slight persistent uplift of about 1 mm a year in the region. Near-fault rheology can help figure out how often an earthquake gate is open or closed.