



# El Mayor – Cucapah Earthquake UAVSAR and a Glimpse of the Future

Sunday, 4 April 2010

3:40 p.m. PDT

$M_w$  7.2

Baja California, Mexico

Ken Hudnut, USGS & John Fletcher, CICESE  
26 March 2013

UAVSAR Workshop  
Jet Propulsion Laboratory





*Borrego Mapping Team - Field Work – April, August, and September 2010*

John Fletcher, Orlando Teran, Ramon Mendoza Borunda, Roman Manjarrez Juarez, Geoff Faneros, Tom Rockwell, Ron Spelz, Joann Stock, Kate Scharer, Sinan Akciz, Javier Gonzalez, Janet Harvey, John Galetzka, Amy Galetzka, Vanessa Andrews, Alison Piasecki, Erika Swanson, Steve Skinner, Eulalia Masana, Dave Lynch, Jim McCrory, Maria, Wally and Ken Hudnut

*CICESE, Caltech, SDSU, App State, UCI, USGS*

Six 4 x 4's plus a quad ATV; 6 days with helicopter support (USGS)



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### **M<sub>w</sub> 7.2 Sierra El Mayor Earthquake**

#### **(Northern Baja California Earthquake)**

A major earthquake has been felt throughout Southern California, Arizona, Nevada, and Baja California Norte, Mexico. The M<sub>w</sub> 7.2 event occurred at 3:40PM PDT, 22:40 UTC, on Sunday, April 4th, 2010. The epicenter was located 30 miles (48 km) SSE of Calexico, CA. The closest town is 11 miles (17.7 km) WSW from the epicenter, located at Guadalupe Victoria, Baja California Norte, Mexico. The fault rupture appears to extend 75 km northwest, from the epicenter in Baja California through the US-Mexico border.

CISN/SCSN Executive Summary (Ken Hudnut, Egill Hauksson, Doug Given, Anthony Guarino, Sae Hough, Kate Hutton, Lucy Jones, Karen Felzer, Bob Dollar)

Version II - Posted at 10:23 AM PDT April 14, 2010

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## Recent comments

- KMZ file updated & how to make air photo pop-out work properly  
6 hours 5 min ago
- strainmeter data  
7 hours 45 min ago
- InSAR image of the earthquake rupture  
12 hours 23 min ago
- Hinged slip  
1 day 17 hours ago
- Envisat SAR acquired on April 13  
1 day 23 hours ago
- Uplift SAR lines return successfully  
1 day 23 hours ago
- USGS activities, Baja California earthquake 4/13/2010  
2 days 13 hours ago
- ASTER images acquired today  
2 days 15 hours ago
- Uplift SAR flight partially successful  
2 days 18 hours ago
- USGS activities, Baja California earthquake 4/12/2010  
3 days 10 hours ago
- Pre-event imagery & KMZ (beta) available  
3 days 10 hours ago
- Up to 2 cm of hinged slip  
3 days 13 hours ago

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## 2010.04.04 - El Mayor - Cupapah Earthquake

View

Tags

Topic: baja-california el-mayor--cupapah laguna-salada mexico sierra-el-mayor

The magnitude 7.2 El Mayor - Cupapah earthquake of Sunday April 4th 2010, occurred in northern Baja California, approximately 40 miles south of the Mexico-USA border at shallow depth along the principal plate boundary between the North American and Pacific plates. This is an area with a high level of historical seismicity, and also it has recently been seismically active, though this is the largest event to strike in this area since 1892. The 4 April earthquake appears to have been larger than the M 6.9 earthquake in 1940 or any of the early 20th century events (e.g., 1915 and 1934) in this region of northern Baja California. See full [summary by USGS](#).

## From Greg Beroza:

As of 8:15pm PDT on Monday, April 5th, 2010, the earthquake has been christened the Sierra El Mayor earthquake. SCEC geologists and geodesists are in the field now, to be followed tomorrow (Tuesday, April 6th) by seismologists. Surface rupture appears to extend across Highway 2, south of the border. Ken Hudnut is coordinating an airborne reconnaissance of surface rupture tomorrow that will provide important constraints on the distribution of faulting.

As of 10:30am PDT on Monday, April 5th, 2010, this is where things stand. The USGS has the earthquake at M 7.2 with a strike-slip mechanism, but with a normal-faulting component. It seems to be on/near the Laguna Salada fault, though that has not been confirmed by observations of surface rupture, so we should not be associating it definitively with that fault. Aftershocks extend to the US side of the border. The Laguna Salada fault had an earthquake of similar size in 1892 (Hough and Elliot, 2004 BSSA). We have made contact with colleagues across the border: Javier Gonzalez is the contact for geodetic observations in Mexico, Victor Wang is the contact for seismological observations, and John Fletcher for geological observations. All of these scientists are at CICESE.

As of 8:15pm PDT, Sunday, April 4th, 2010 this is where things stand. The USGS has the earthquake at M 7.2 with a strike-slip mechanism. It seems to be on/near the Laguna Salada fault, which had an earthquake of similar size in 1892 (Hough and Elliot, 2004 BSSA). Today's earthquake has been a bit challenging having happened on Easter Sunday and just across the border. We have made contact with colleagues across the border, but it look awhile. SCEC is gearing up for possible seismic, geodetic, and geologic fieldwork, but how it goes from here depends strongly on what we learn about what is possible to carry out in Mexico. There also may be the issue that non-SCEC instruments are scattered far and wide: in Haiti and Chile. Mike Oskin has made contact with John Fletcher at CICESE (Ensenada), who is headed out to the field tomorrow and is interested in collaborations. I have also heard back from Carlos Valdes, who is head of the Mexican National Seismological Service. I let him know that scientists here are interested and available to collaborate and that we should try to coordinate our response. He has not yet managed to get through to CICESE, but will be in touch with us tomorrow.

## Attachments/Uploads

- [Moment Tensor Solution](#)
- [Horizontal Displacements](#)
- [11/2 Rinex Data](#)
- [SCEC -MDO Images \(UCERF2 Faults, CPM 2.5 Faults, CPM 2.5 Faults \(from the North\)\)](#)
- [Aftershock Zone and Active Faults \(Bajajec.org\), Bajajec.pdf](#)
- [Coulomb Stress Change \(version: 1.0, 1.1\) - Calculations \(version: 1.1\)](#)

## Who's online

There is currently 1 user and 1 guest online.

- Tunal

## USGS Significant Earthquakes

- [Magnitude 4.9 UTAH April 15, 2010](#)
- [04/14/2010 - Is Recent Earthquake Activity Unusual? Scientists Say No](#)
- [Magnitude 6.8 SOUTHERN QINGHAI, CHINA April 13, 2010](#)
- [Magnitude 6.9 SOUTHERN QINGHAI, CHINA April 13, 2010](#)
- [Magnitude 6.3 SPAIN April 11, 2010](#)

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## Southern California Seismic Network

- [Southern California Earthquake in the](#)
- [Weekly Seismicity Report](#)

more

<http://earthquake.usgs.gov/earthquakes/eqinthenews/2010/ci14607652/>

**PAGER - M 7.2 - 30.8 mi SSE of Calexico, CA**

Alert Version: 8

Sunday, April 4th, 2010 at 22:40:42 UTC

Location: 32.3° N, 115.3° W Depth: 10km

Event Id: CI14607652

Created: 3 days, 10 hours after earthquake.

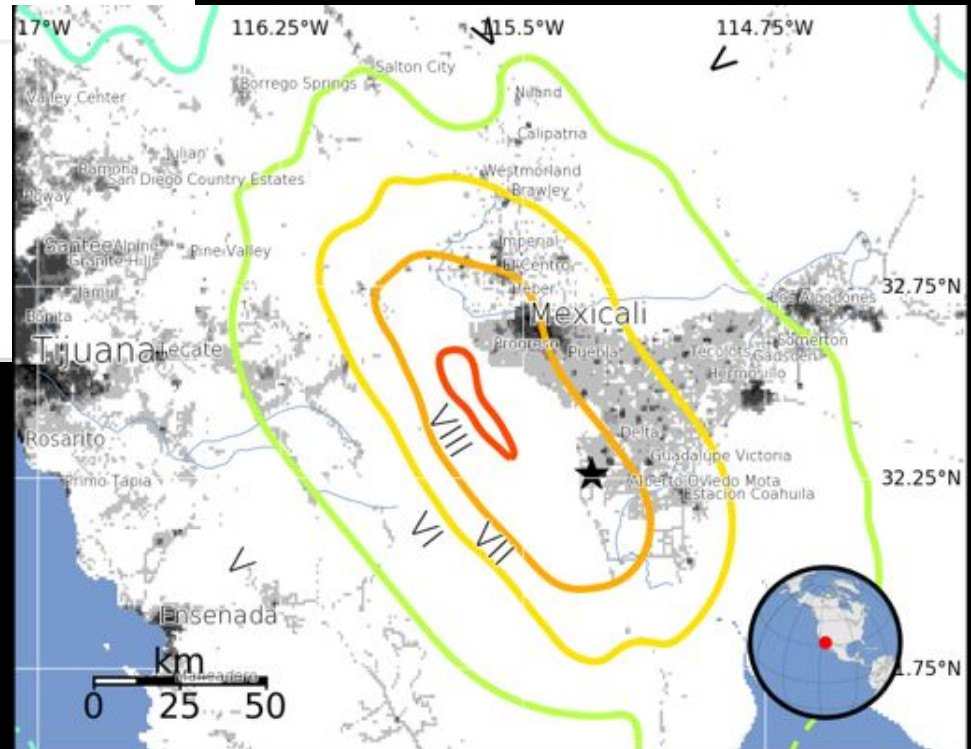
Overall, the population in this region resides in structures that are a mix of vulnerable and earthquake resistant construction. A magnitude 6.5 earthquake 88 km Northwest of this one struck Imperial Valley, California on October 15, 1979 (UTC), with estimated population exposures of 3,000 at intensity IX and 291,000 at intensity VIII, resulting in 0 fatalities, 91 injuries, and an estimated 30 Million US Dollars in damage. Recent earthquakes in this area have caused landslides and liquefaction that may have contributed to losses.

Exposure Summary Full City Exposure List Downloads

**Estimated Population Exposed to Earthquake Shaking**

Est. Modified Mercalli Intensity	Est. Population Exposure	Perceived Shaking	Potential Structure Damage	
			Resistant	Vulnerable
X	0	Extreme	V. Heavy	V. Heavy
IX	300	Violent	Heavy	V. Heavy
VIII	525k	Severe	Moderate/Heavy	Heavy
VII	373k	Very Strong	Moderate	Moderate/Heavy
VI	301k	Strong	Light	Moderate
V	2,883k*	Moderate	V. Light	Light
IV	112k*	Light	none	none
III-II	--*	Weak	none	none
I	--*	Not Felt	none	none

Mexicali at MMI VII  
~600,000 people



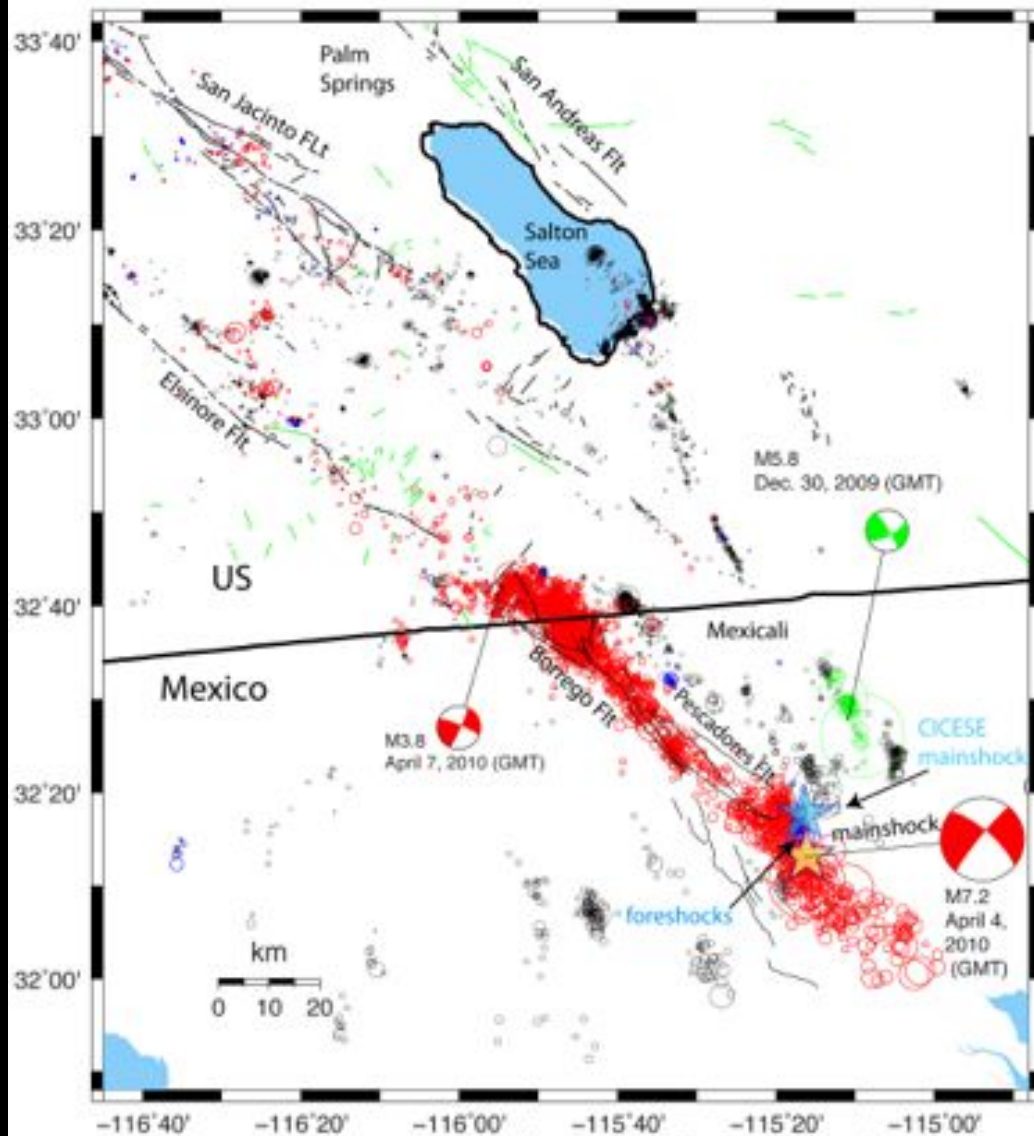
courtesy of P. Earle, USGS NEIC

# SCSN/CISN Recorded Seismicity (red) April 4– 12, 2010

Relocated with 3D Model and HypoDD

2009 Seismicity in Black; and 30–31 Dec. 2009 in Green

Foreshocks since 20th of March in blue



courtesy of  
E. Hauksson,  
Caltech

GMT 2010 Apr 13 18:59:33

E. Hauksson Caltech

Version 6

Blue star – CICESE epicenter for mainshock

Yellow star – SCSN relocated mainshock epicenter

Only clustered events are shown.

Faults in Baja provided by J. Stock, Caltech

Mainshock moment tensor -- only double couple shown

# Surface ruptures on Borrego fault



# Hwy MEX 2D fault crossing



photo courtesy of Yuri Fialko





# Airborne recon photos 4/6/10



Pescadores fault



Borrego fault



Borrego fault



Laguna Salada fault

# Sierra Cucapa

Paso Superior D

Puerto de Amador (1900)

Zaragoza D

Zaragoza D

Cerro Prieto

N

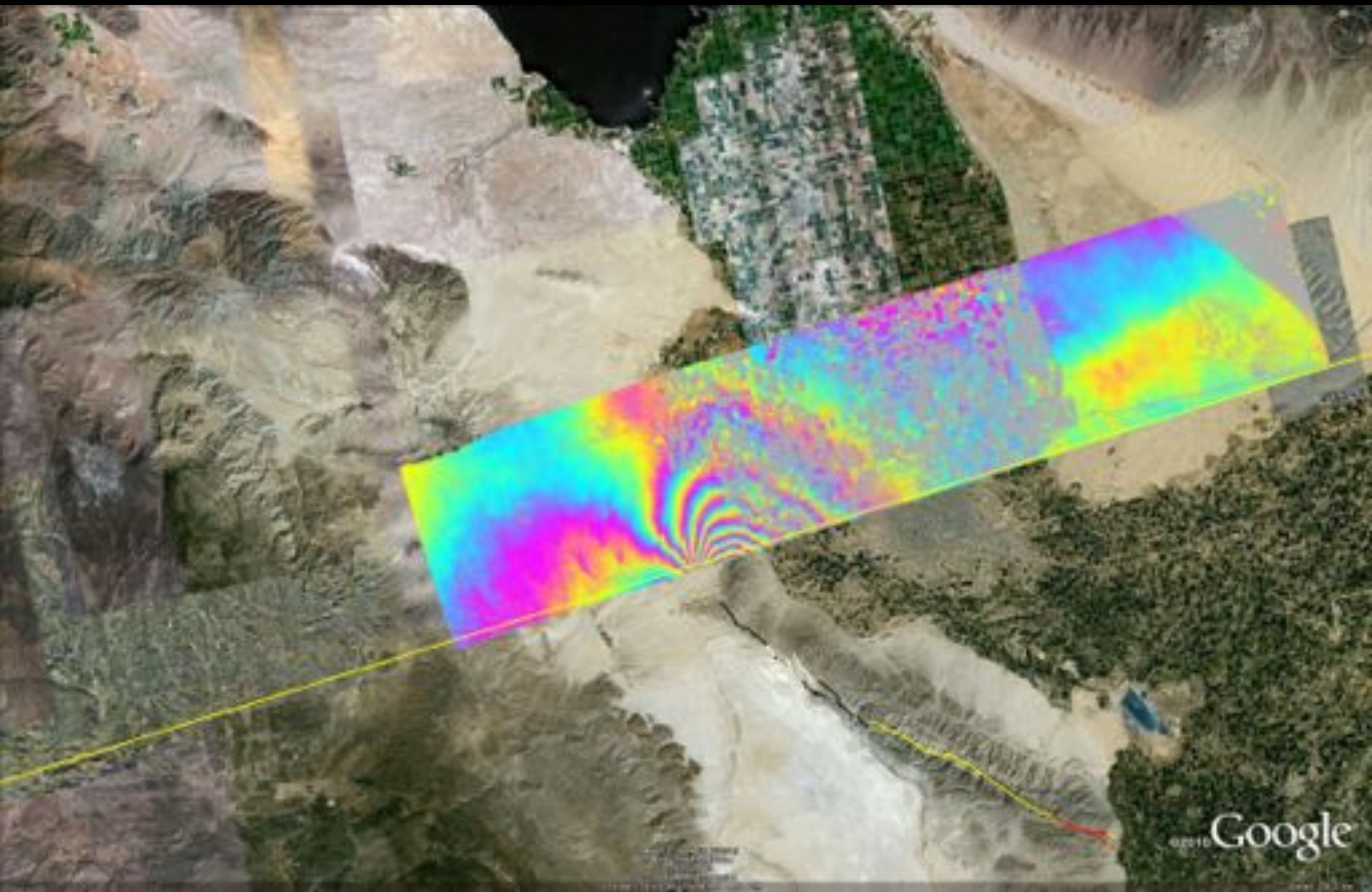
0 5 10  
kilometers

Carada David D

©2009 Google







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Courtesy of Eric Fielding, JPL

# aerial photos now at ~1 cm GSD

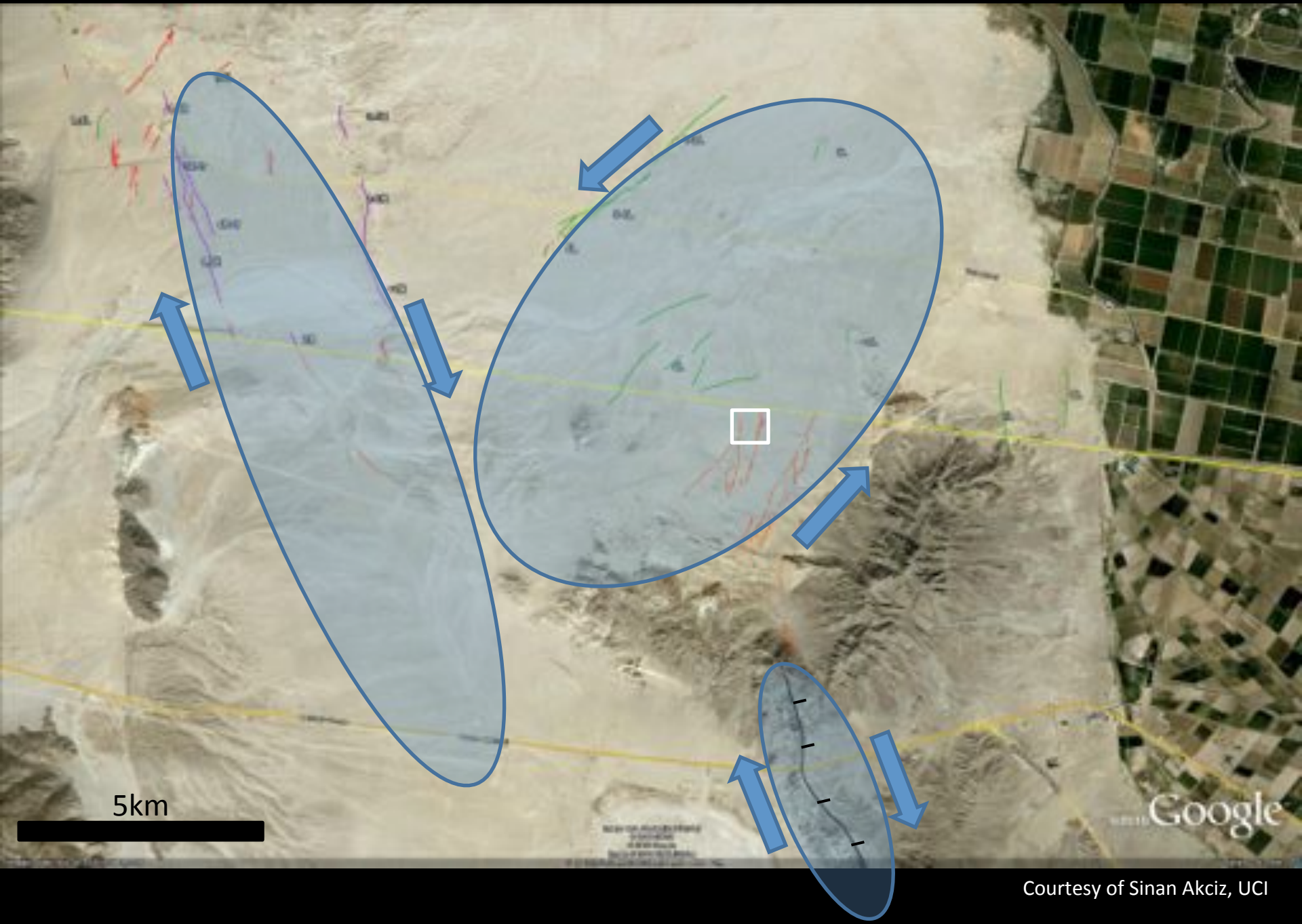
<ftp://pipeline.gps.caltech.edu/pub/users/hudnut/aerialsurveys>



**Yuha fault using D90 w/ GP-1 at ~50 m AGL; 105 mm, full auto, ~1 fps**

- guiding air recon and photo flights with latest satellite & airborne imagery
- precise location of rupture features leads to very efficient air photo flights
- map directly from georeferenced photos; GPS coord's in EXIF headers
- locate best quality offset features to go measure in the field, saving field time





5km

Google

Courtesy of Sinan Akciz, UCI

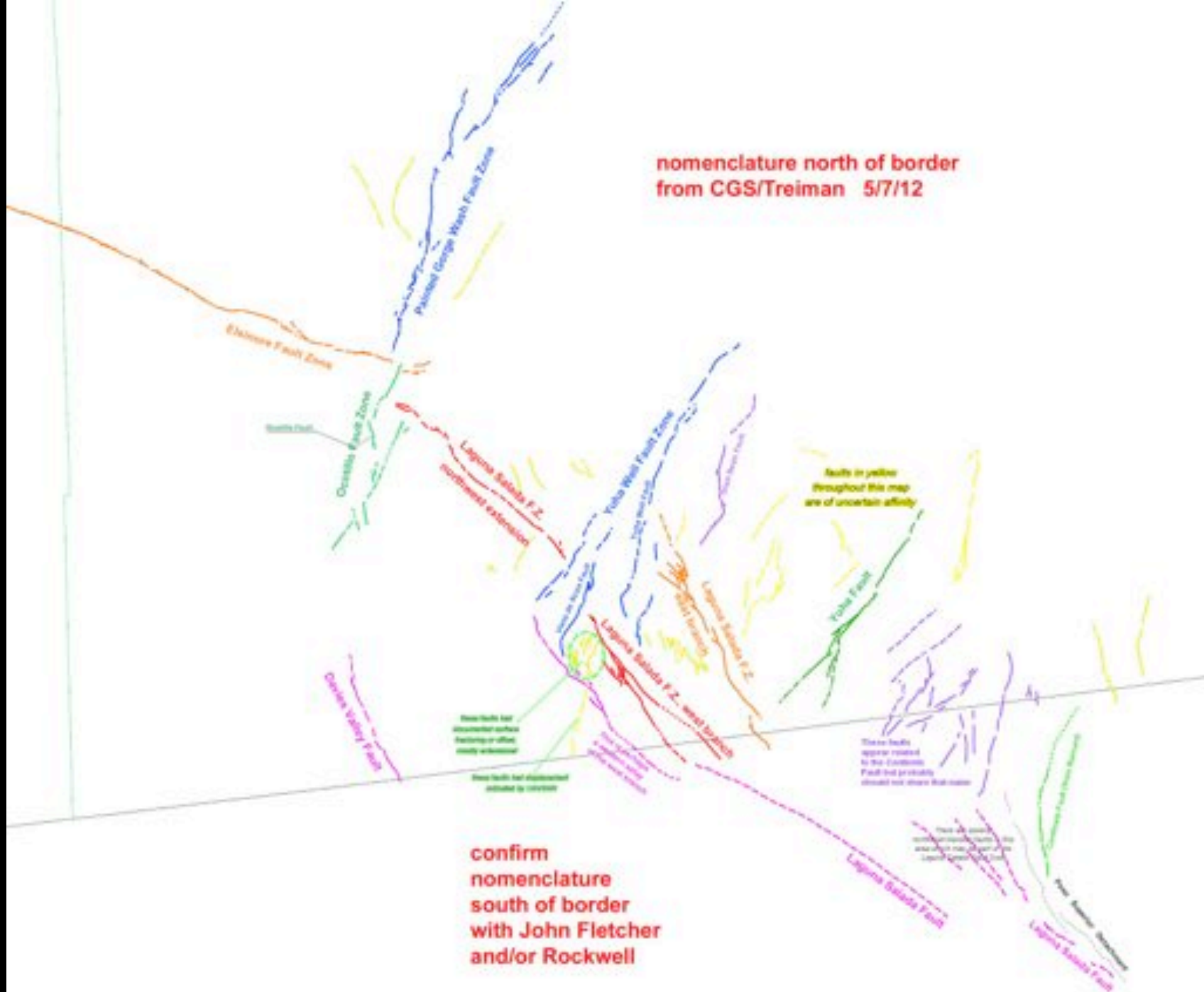


100 m

Google



nomenclature north of border  
from CGS/Treiman 5/7/12



# UAVSAR and a Glimpse of the Future

- For major surface-rupturing earthquakes in the future, UAVSAR will likely be one of the most important sources of imagery for identifying faults that ruptured.
- Rapid deployment is possible and would be desirable, but also could be delayed by real-world factors such as post-disaster air space restrictions & availability.