Earthquake Threat in Southern California

Get Ready to ShakeOut!
10:18 a.m. on October 18, 2012

Margaret Vinci

Caltech, Seismological Laboratory

Office of Earthquake Programs

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Earthquake Country **Alliance**

We're all in this together.

Objectives

- Share the latest understanding of our earthquake hazards
- Provide you with earthquake safety resources and information at work, home and retail stores
- Invite you to get ready to “ShakeOut” and drill your plan

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California Multi-Hazard State

- Winds
- Landslides
- Fires
- Floods/Debris Flow
- Tsunami
- Earthquakes

  landslides

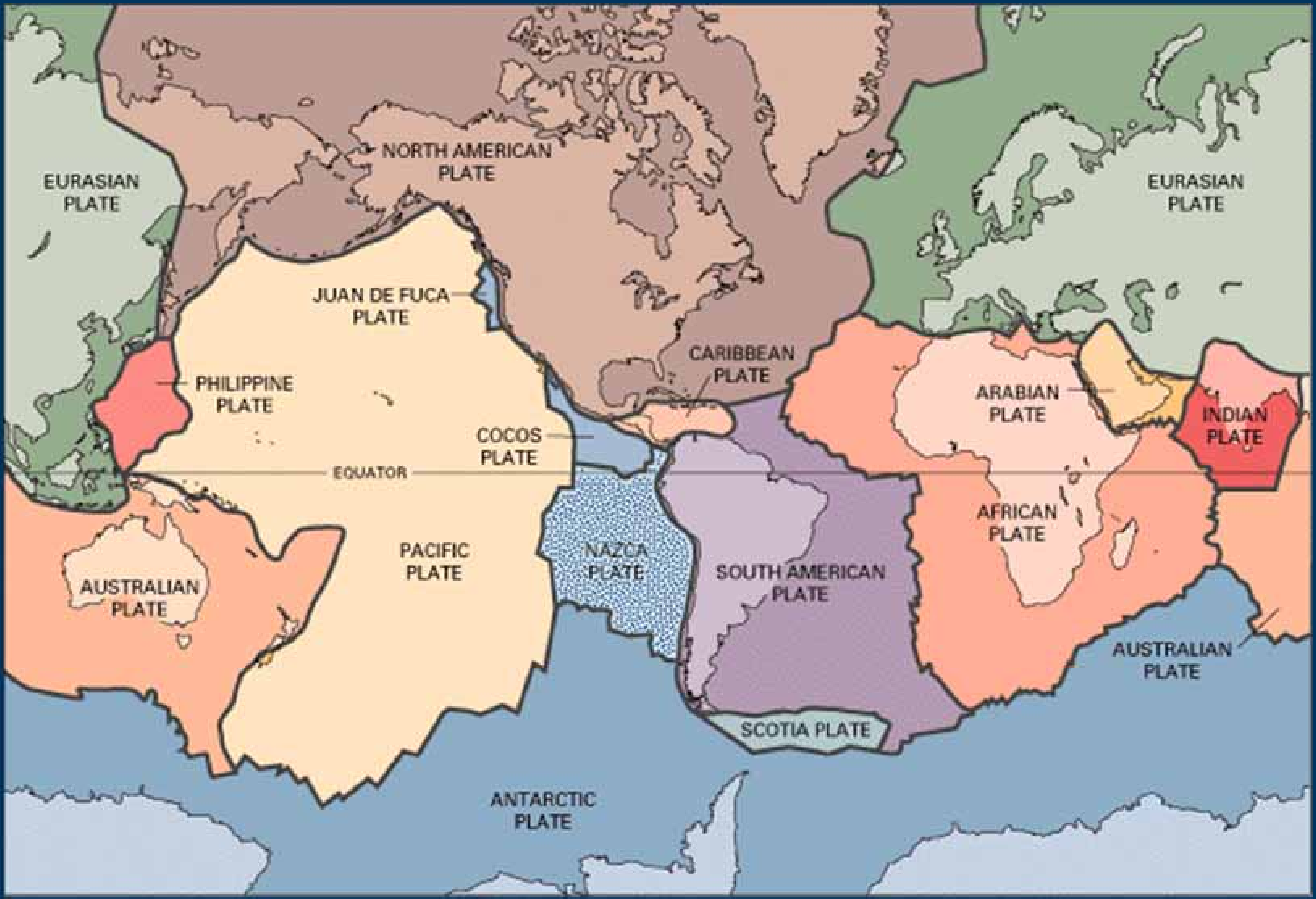
  fires

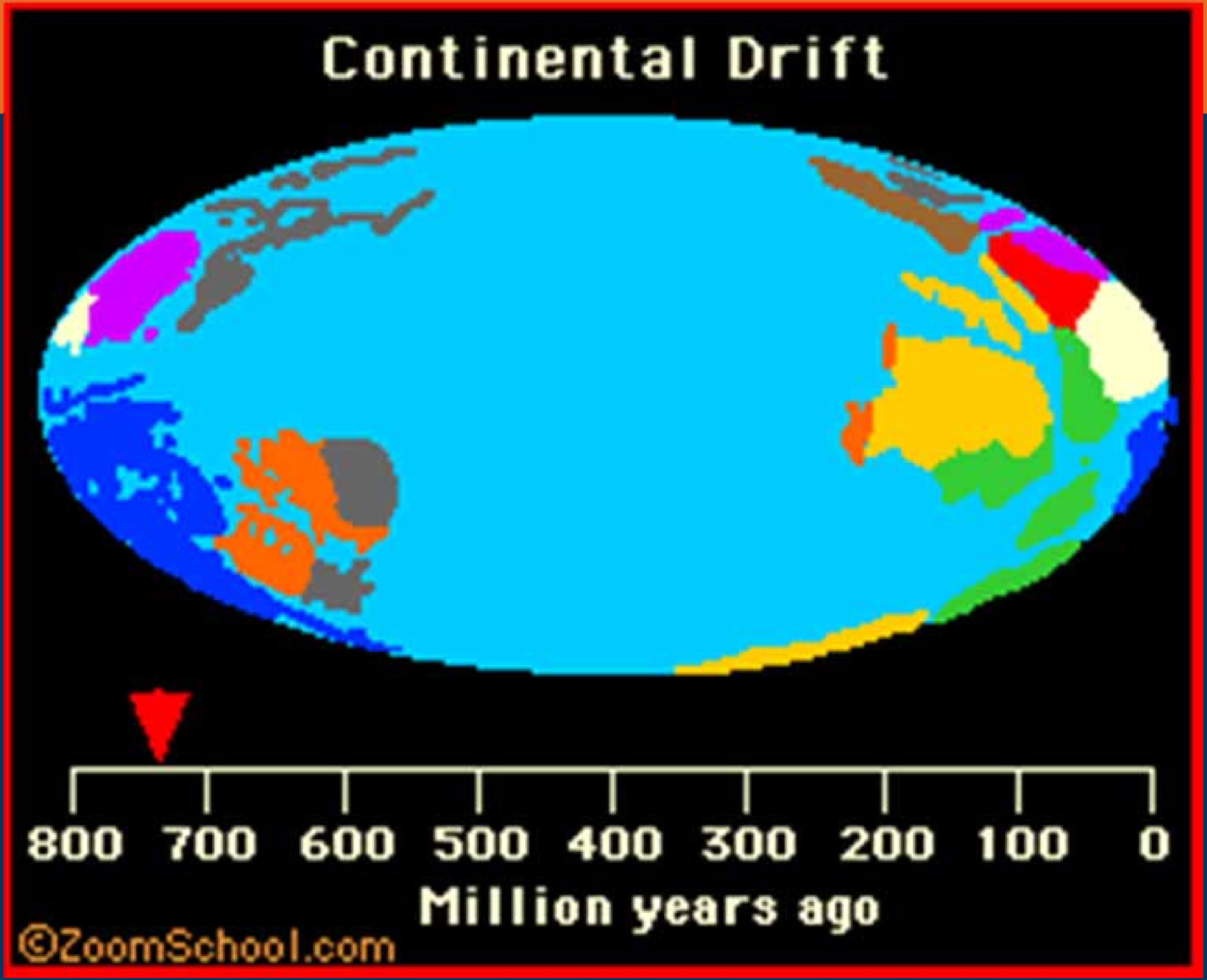
  floods

  tsunami

ShakeOut

Plate Tectonics




Continental Drift
800
700
600
500
400
300
200
100
0
Million years ago
©ZoomSchool.com

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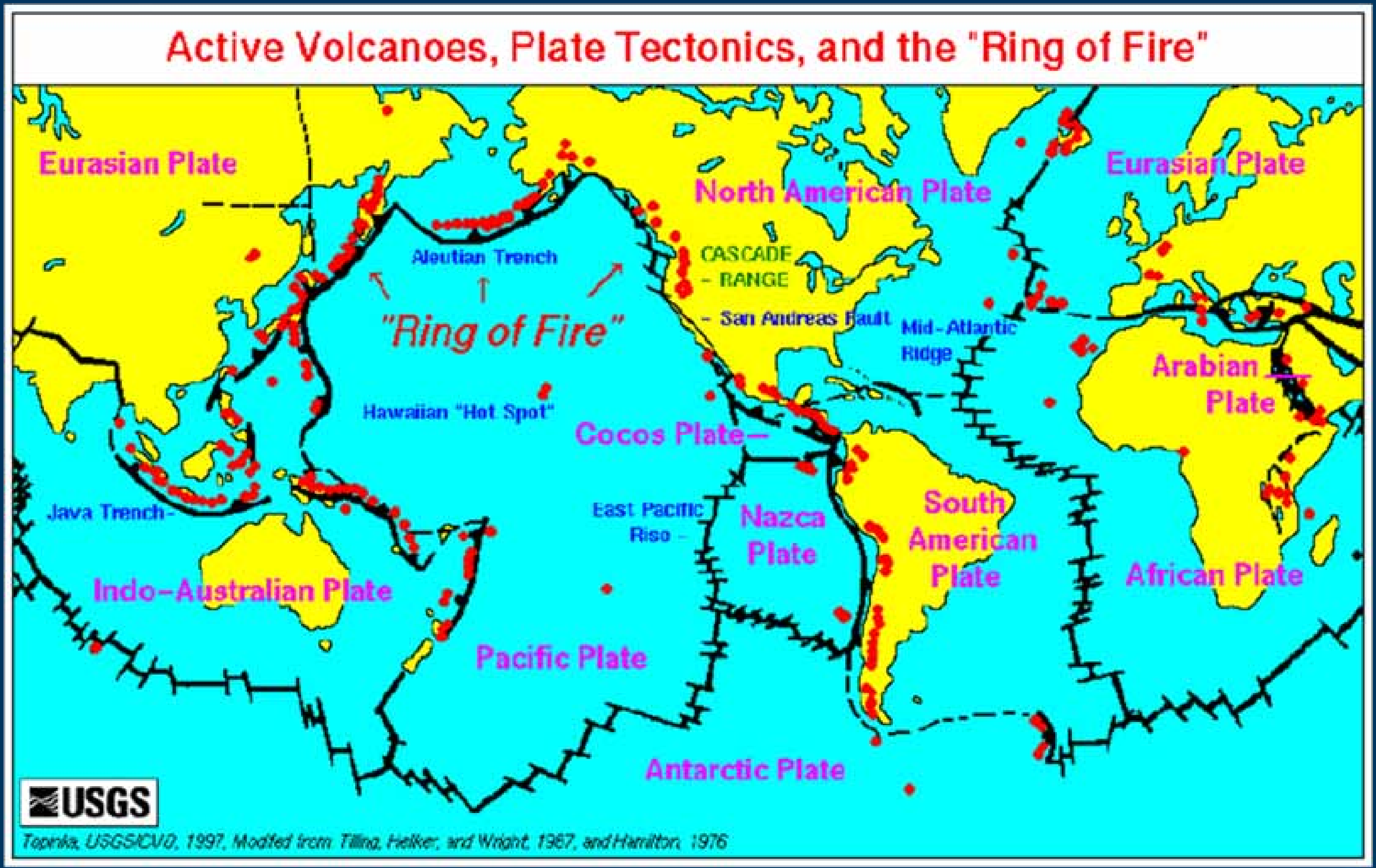
Ring of Fire

Most earthquake occur along the tectonic plate boundary

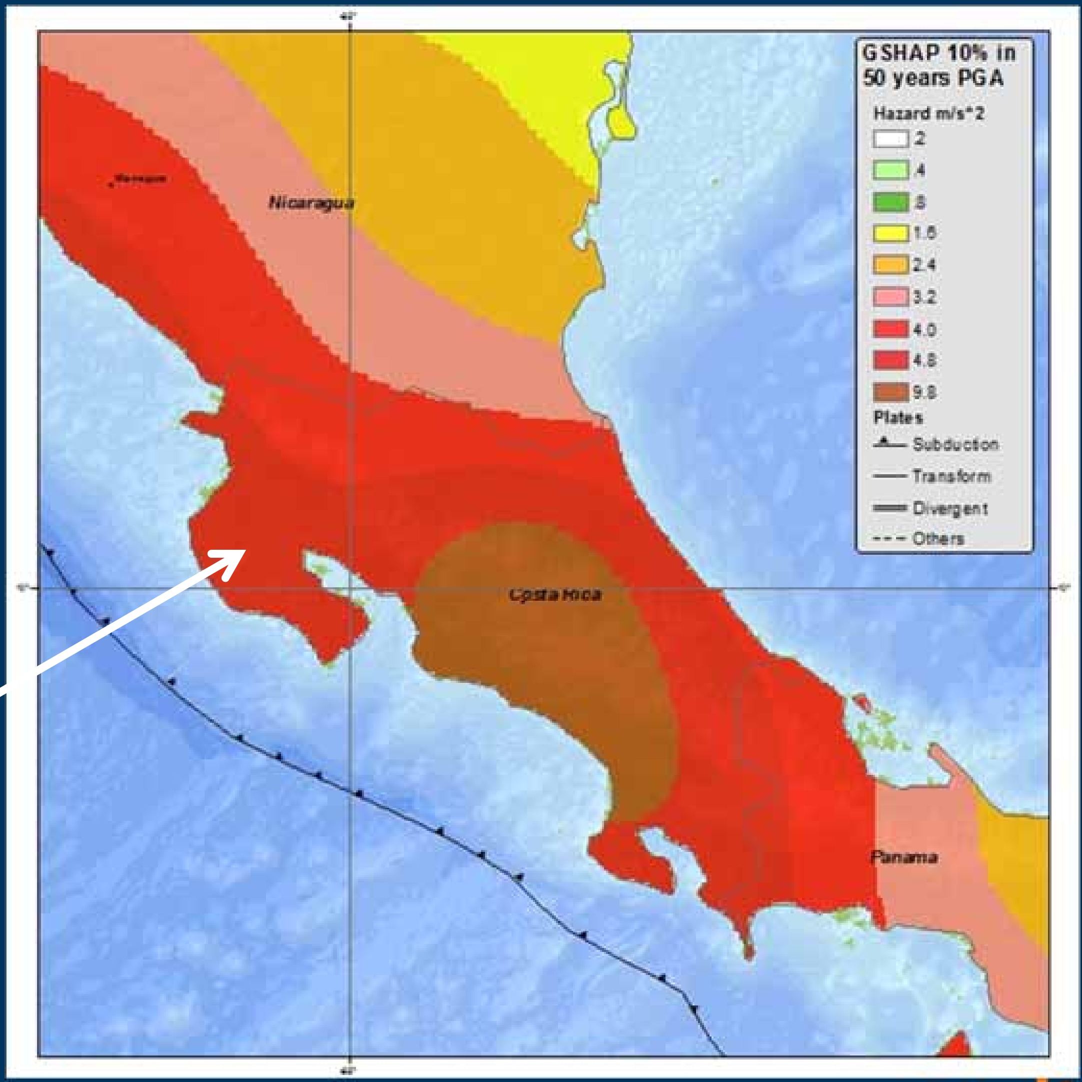


Seismic Hazard Map of Costa Rica

Sept. 5, 2012 Hojancha

M7.6 earthquake beneath Nicoya Peninsula occurred as a result of faulting on or near the subduction zone Interface between the **Cocos and Caribbean plates**

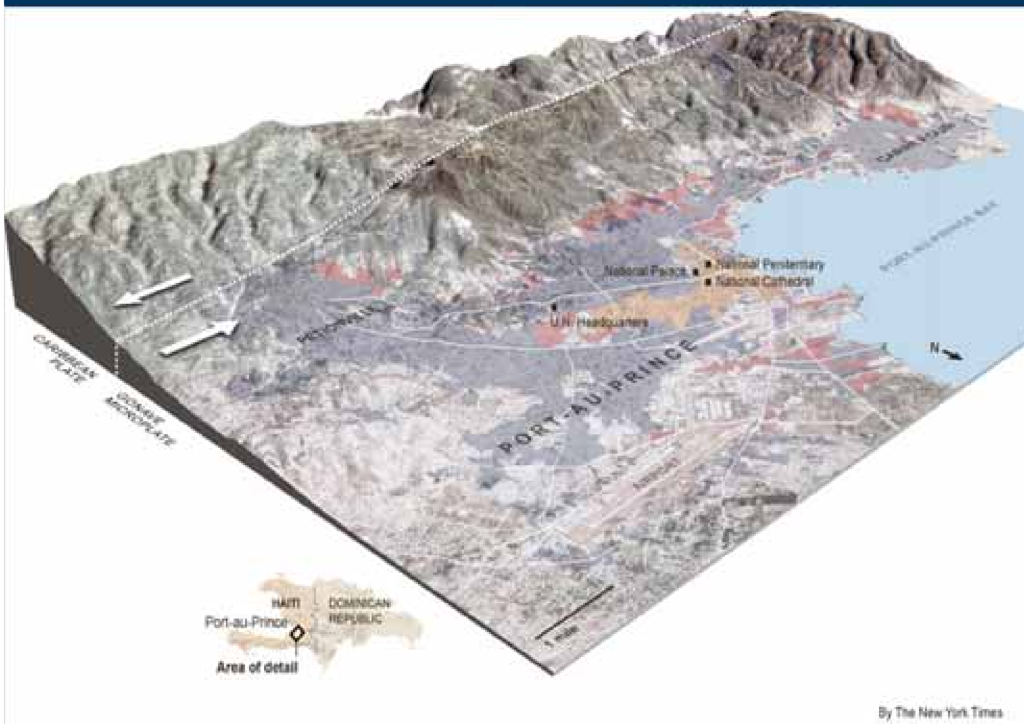
Past 40 years region within 250 miles experienced ~30 earthquakes M6 or greater (two of these larger than M7)



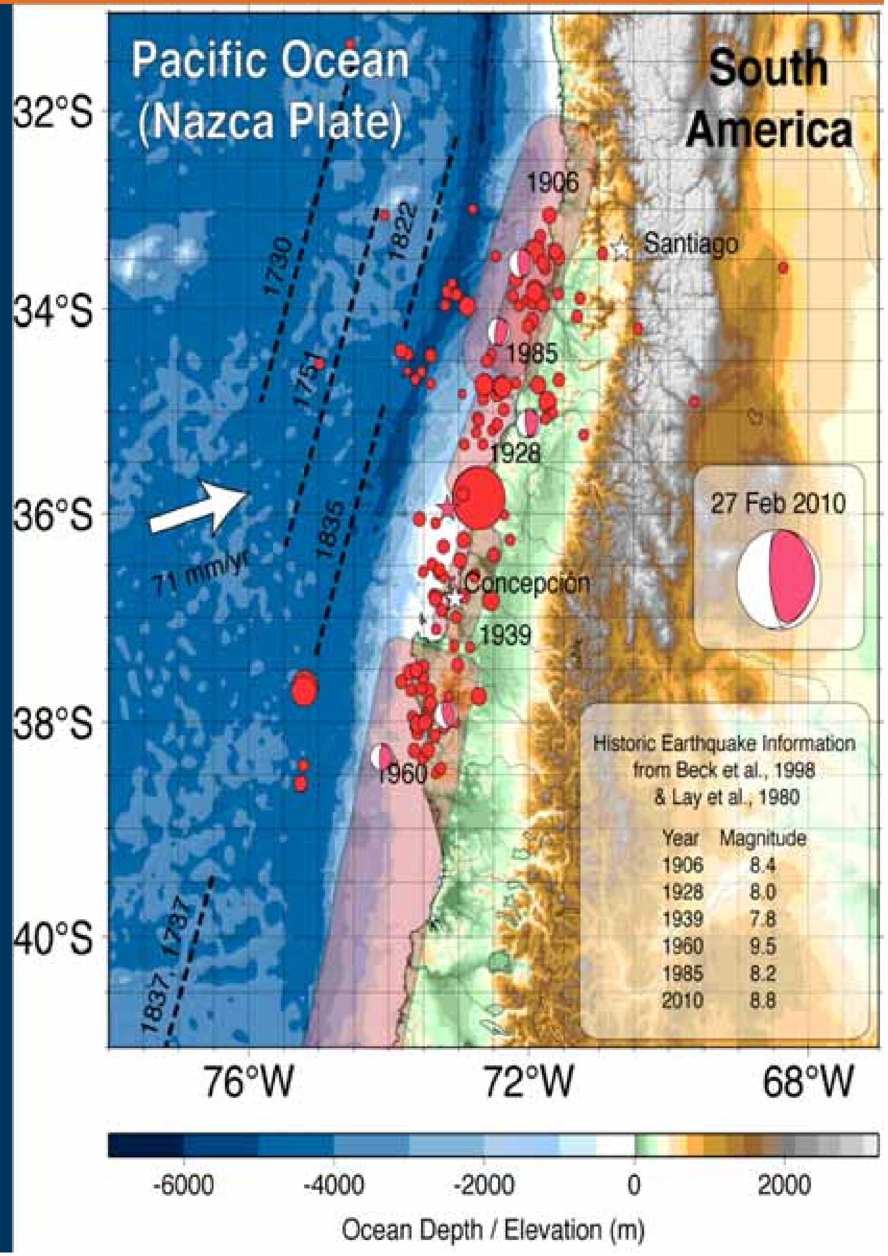
Haiti – M7.0 1/12/10 Chile – M8.8 2/27/10

500 X more energy released in Chile

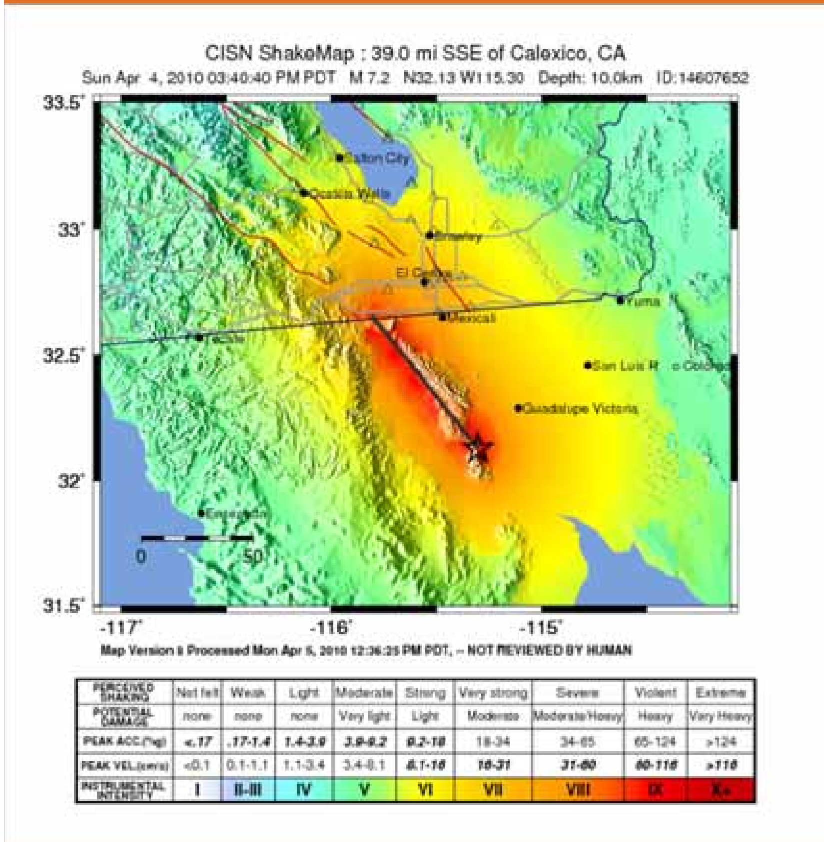
Nazca and South America Plate Boundary in Pacific Ocean



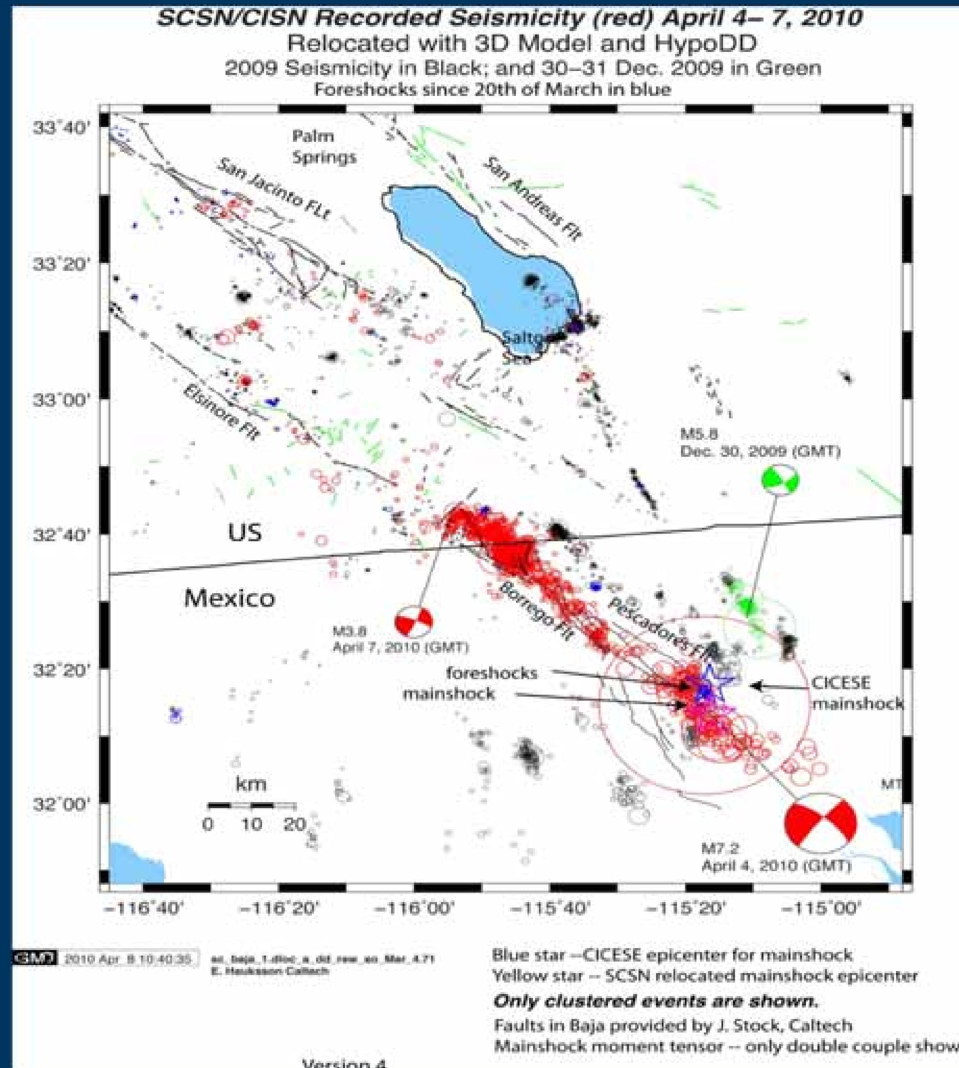
Carribean Plate and Conave Microplate Boundary under mountain range



M7.2 Sierra El Mayor-Cucapah Earthquake



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



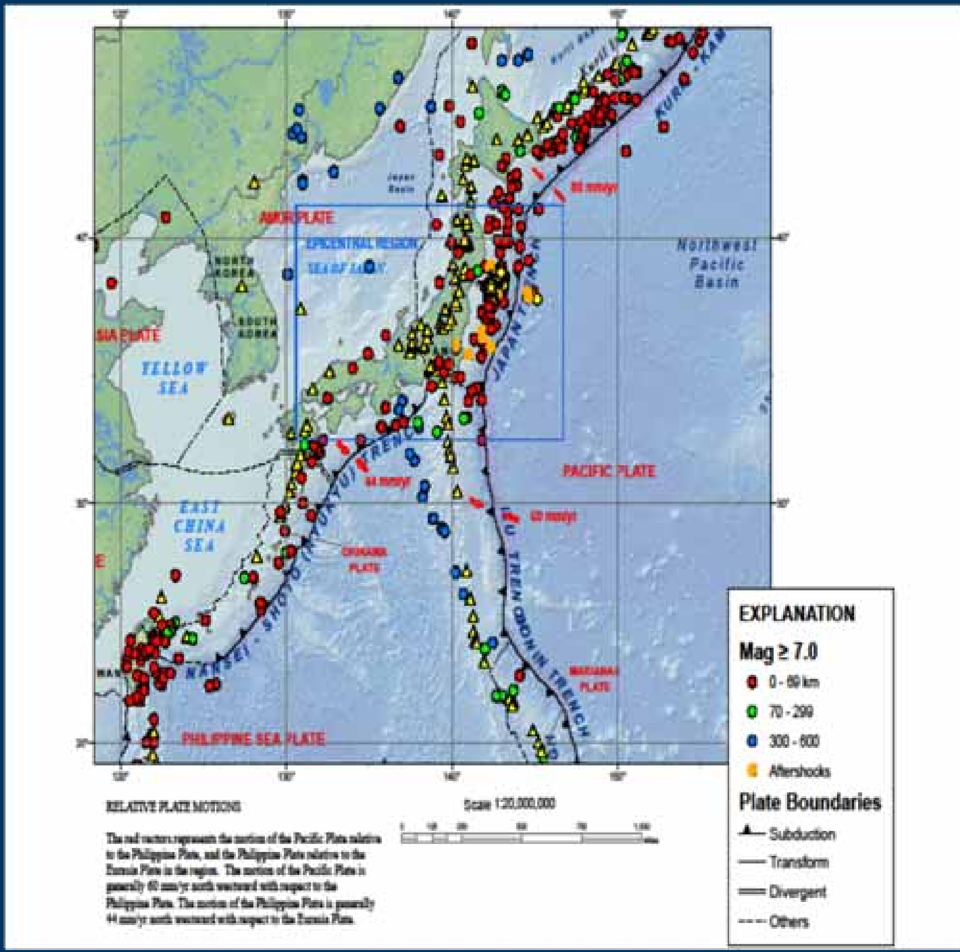
Caused extensive rupture on 28 km portion of the Borrego fault and the Pescadores fault in northern Baja (140 miles)

4,000 aftershocks (8 M5-6; 65 M4-5)

El Mayor-Cucapah EQ/Imperial Valley

- $100 million is losses
- 3,000 people without jobs
- 52 mobile homes knocked off foundation
- 30 businesses red tagged
- 260 more businesses disrupted waiting inspection
- Extensive damage to irrigation and water supply
- 3 weeks to get water tanks trucked in

Japan Plate Tectonics



- Japan sits in the middle of 3 plates (Pacific, Eurasia, Phillipine)

- Subduction zone fault creates largest earthquakes and often tsunamis. Coastline dropped 2 ft allowing tsunami to move fast onto land

- Thrust fault near the subduction zone plate boundary. Pacific plate subducting under plate under Honshu. Motion pulls upper plate down until stress releases it causing an earthquake

- Seafloor moved upwards several meters and fault zone ruptures over a length of 310 mi and width of 120 mi

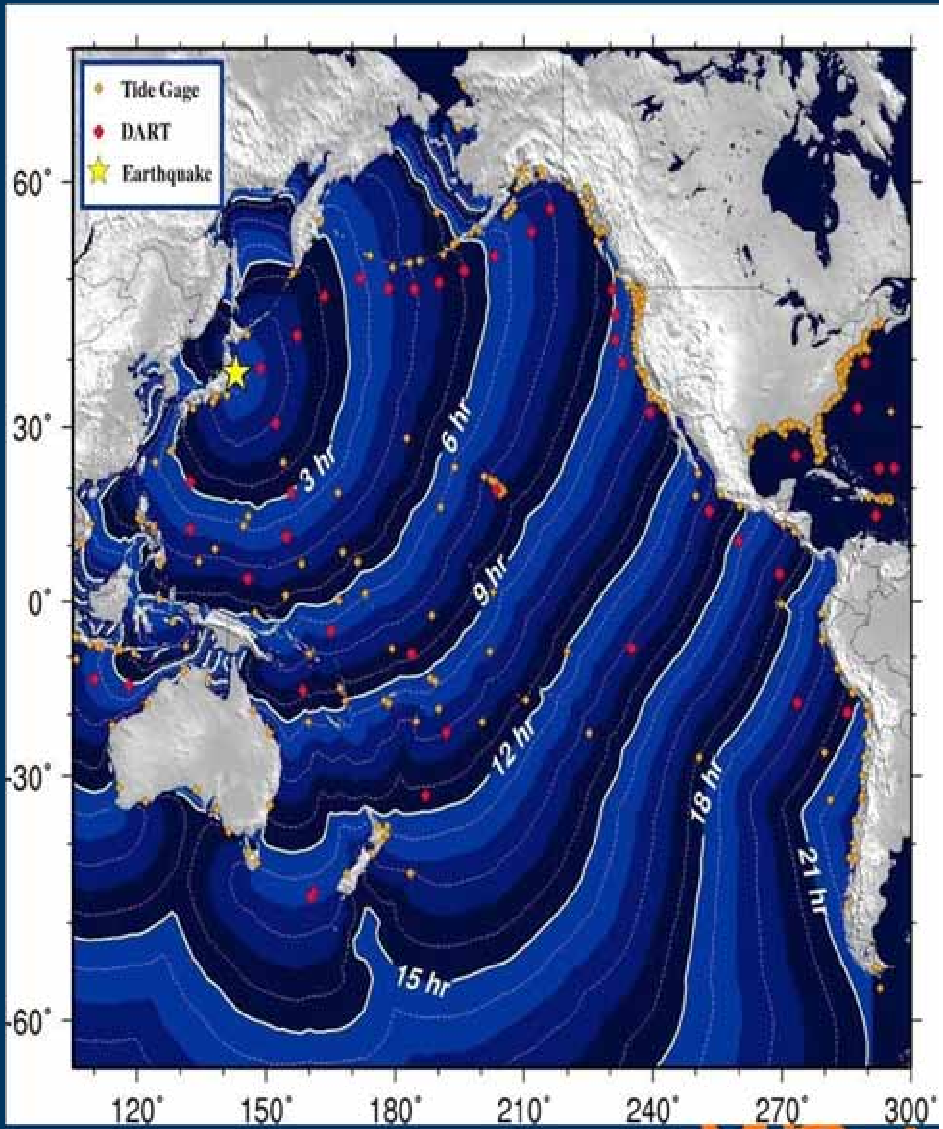
•Moved northeastern Japan 7.9ft closer to No. America and shifted Earth on its axis 4 inches.

Tsunami – estimated travel time
Previous large tsunamis struck this area in 1896, 1933,1960 (Peru EQ)

• Earlier tsunamis in 869 and 1611

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

5 to 8 meter upthrust on 180 km wide seabed offshore
Resulted in major tsunami 33 ft high in some places



Timeline of Events: (Pacific time)
9:46 PM Pacific Time Quake strikes
+8 sec: Earthquake Early Warning (Japan)
+3 min: Tsunami Warning (Japan)
+6 min: NOAA Tsunami Warning
+10 min: USGS ENS as M7.9
+10 min: Tsunami strikes NE Japan
+8 hr: Tsunami hits Hawaii
+7 hr: Humbolt tsunami sirens
+9-10 hr: Tsunami hits West Coast

•Surges persisted on Northern CA for 3 days
•First surges not the largest
•Highest surge at Crescent City 8.2 ft (**low tide**)
•Commercial boats exited harbor

Damage in California - $48 M statewide
Crescent City, Santa Cruz, Ventura, Bay area due to Strong currents

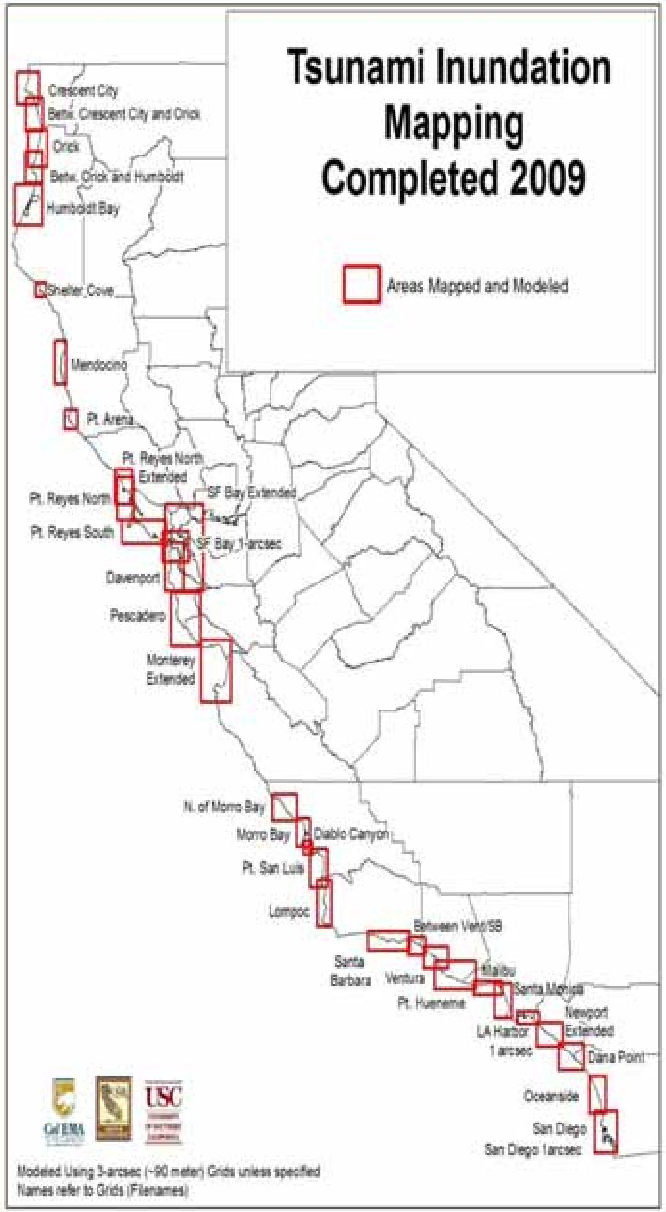
How Can I Protect Myself from a Tsunami?

- Check to see if you are in Tsunami area
- Plan an evacuation route from your home, school, work or vacation spot
- Learn natural warning signs:
  - An earthquake (DCHO & go to higher ground)
  - Water receding or surging out to sea
  - Water surging inland
  - A loud roaring sound coming from the ocean
- Prepare Go-Kits for 3 or more days
- Be aware – know evacuation routes in area; radio with NOAA alerts

Tsunami Threat in So California…

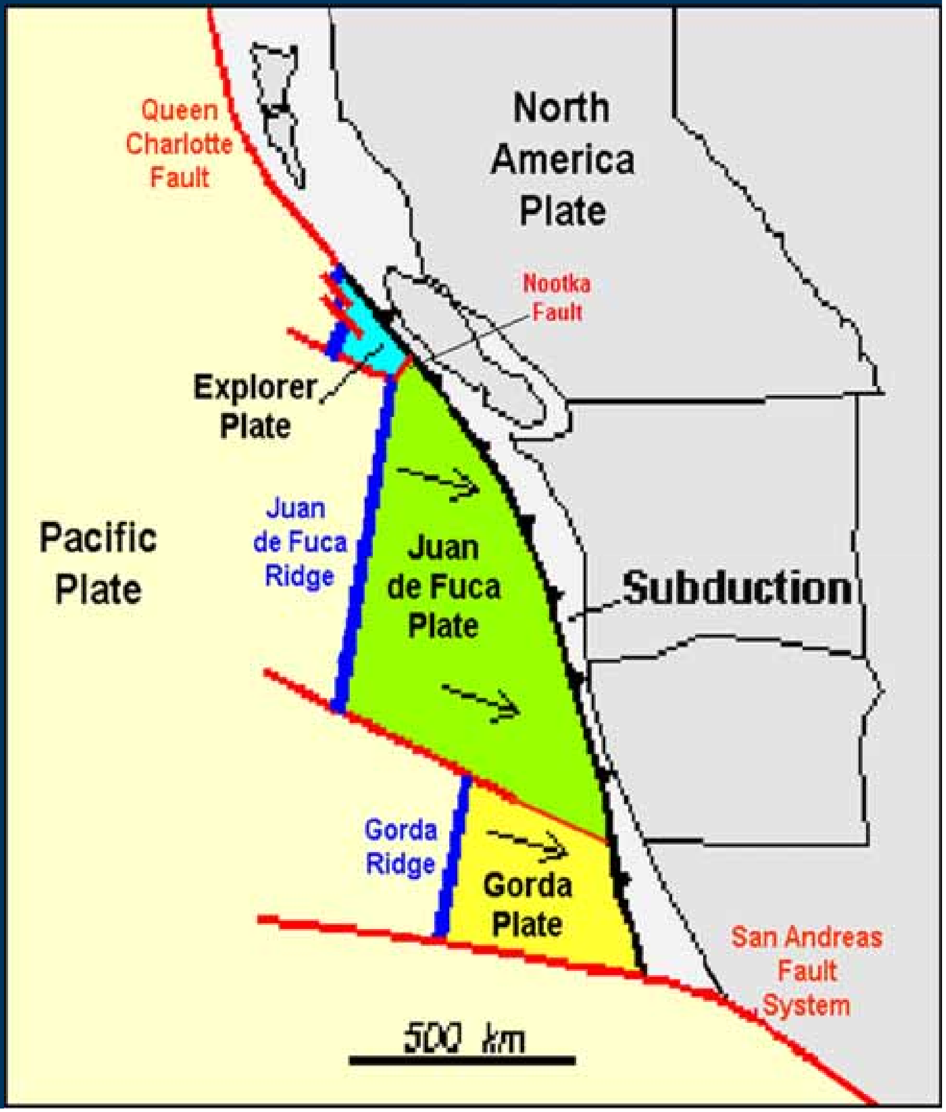
- Remote large earthquakes in Japan, Hawaii, Aleution Islands , Alaska, Chile can create a damaging tsunami affecting the Pacific Northwest and California
- Crescent City, CA is historically a site of tsunami's created by remote earthquakes in no. California
- A tsunami generated by a nearby **offshore** fault is possible but would not create significant damage
- Threat from tsunamis caused by under water landslides created by **onshore** fault ruptures close to shoreline (Newport Ingelwood, Palos Verdes, Wilshire, Puente Hills)
- Recent inundation reports from CGS indicate tsunami waters inundating as much as 6 blocks at the lowest point at Marina Del Rey
- Damage to Port of Los Angeles and Long Beach
- Nuclear power plants – San Onofre and Diablo

http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_maps/



California Earthquakes

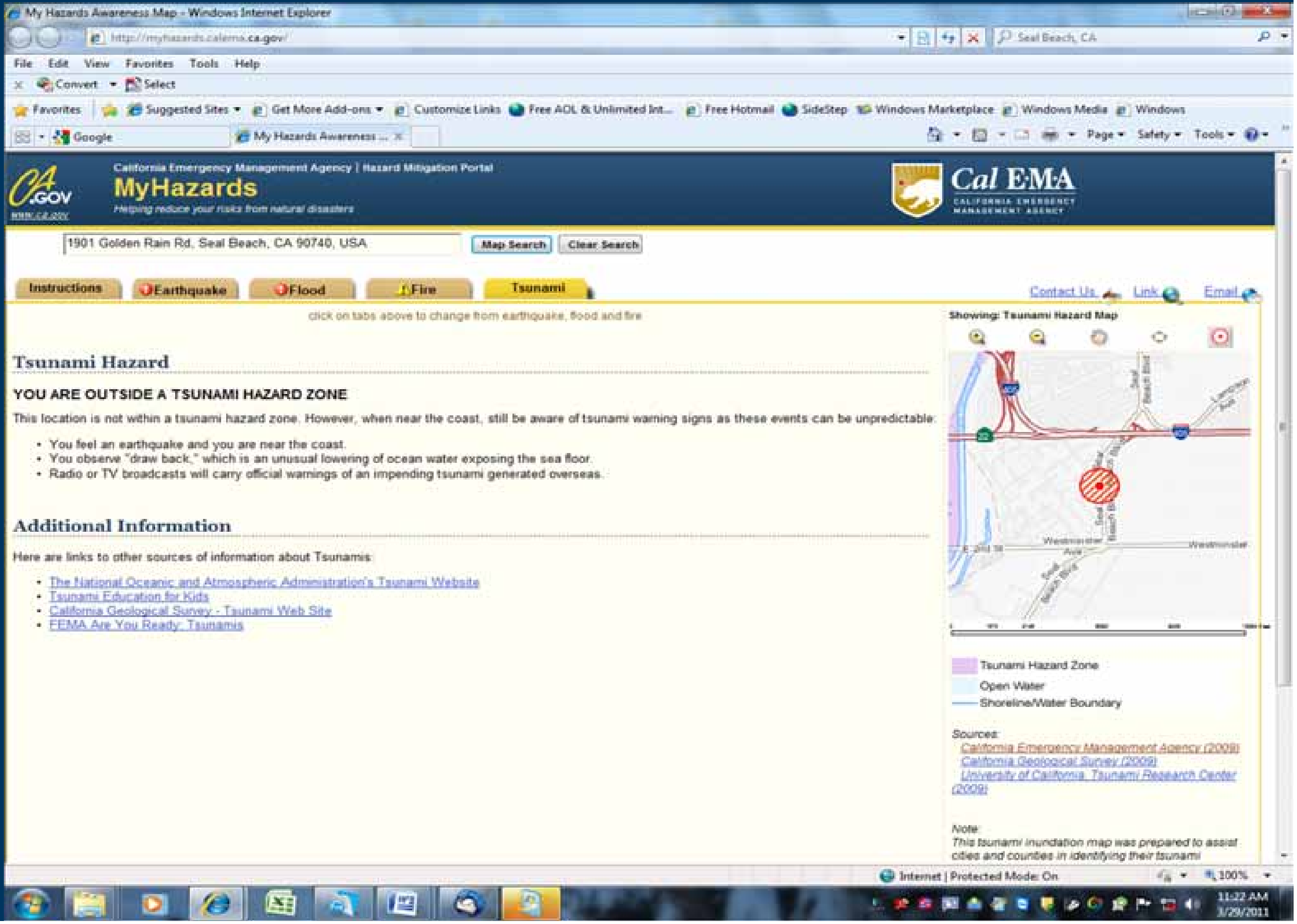
- Cascadia earthquake zone in the northern portion of California and the Pacific Northwest is a subduction zone prone to larger earthquake events than the San Andreas Fault System in so. California



http://myhazards.calema.ca.gov

Website will provide hazard zone information based on a particular address in California

- earthquake
- tsunami
- flood
- fire

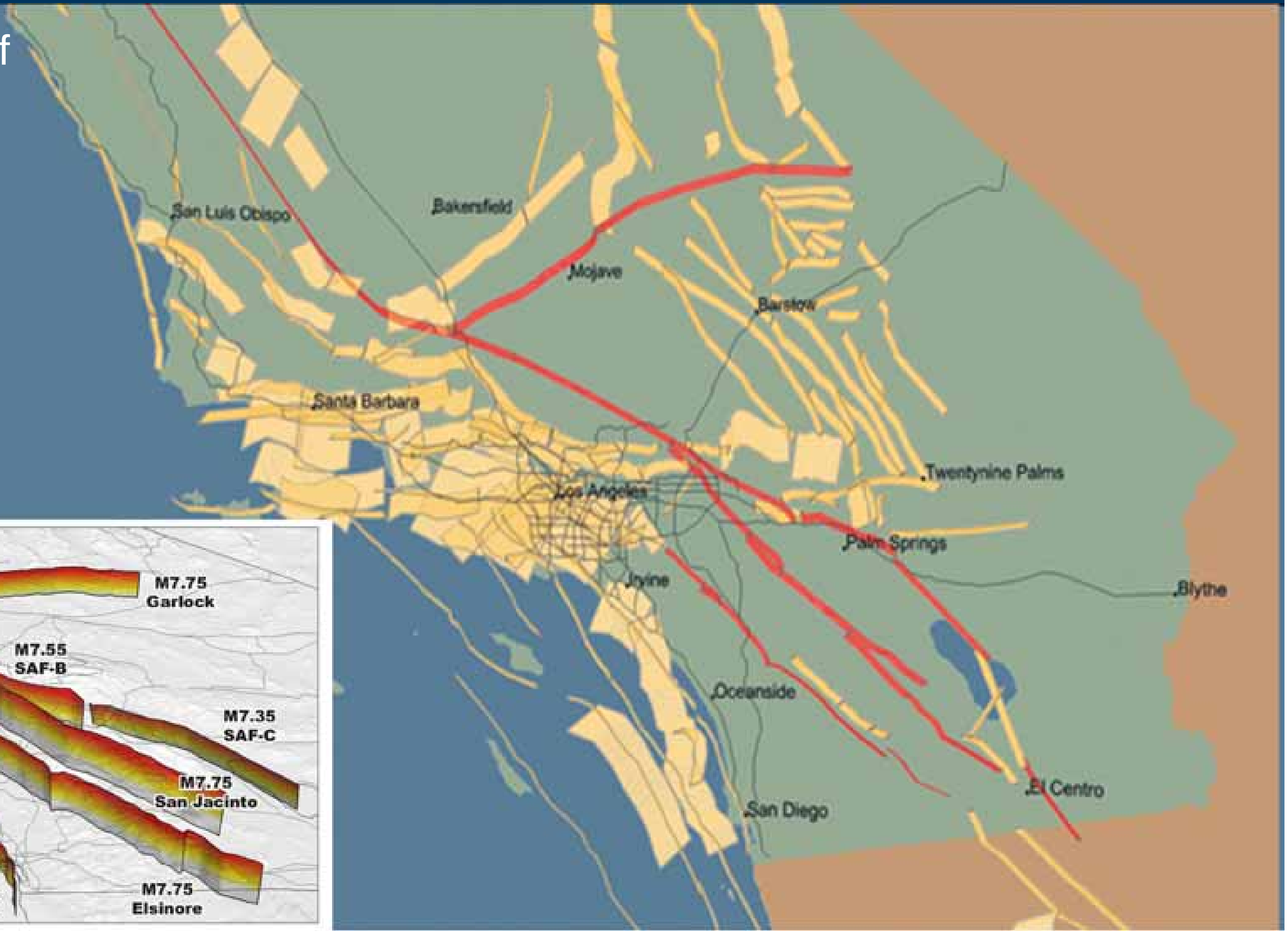


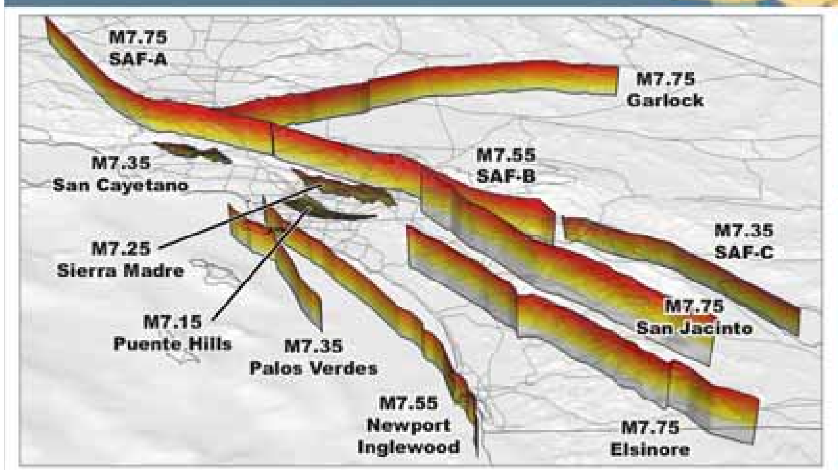
SoCal Active Faults

300 known faults in So. California

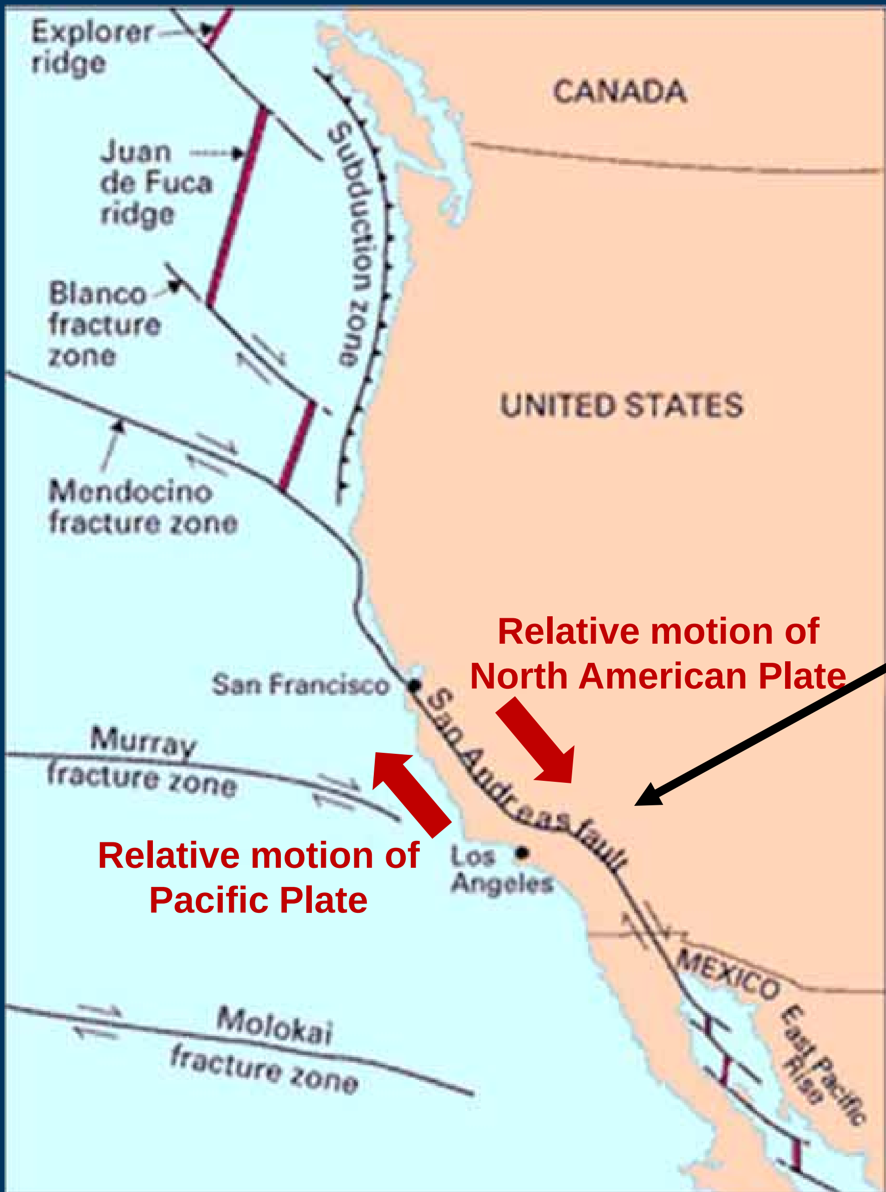
24 faults capable of large earthquake

12 faults within LA Basin capable of large earthquakes





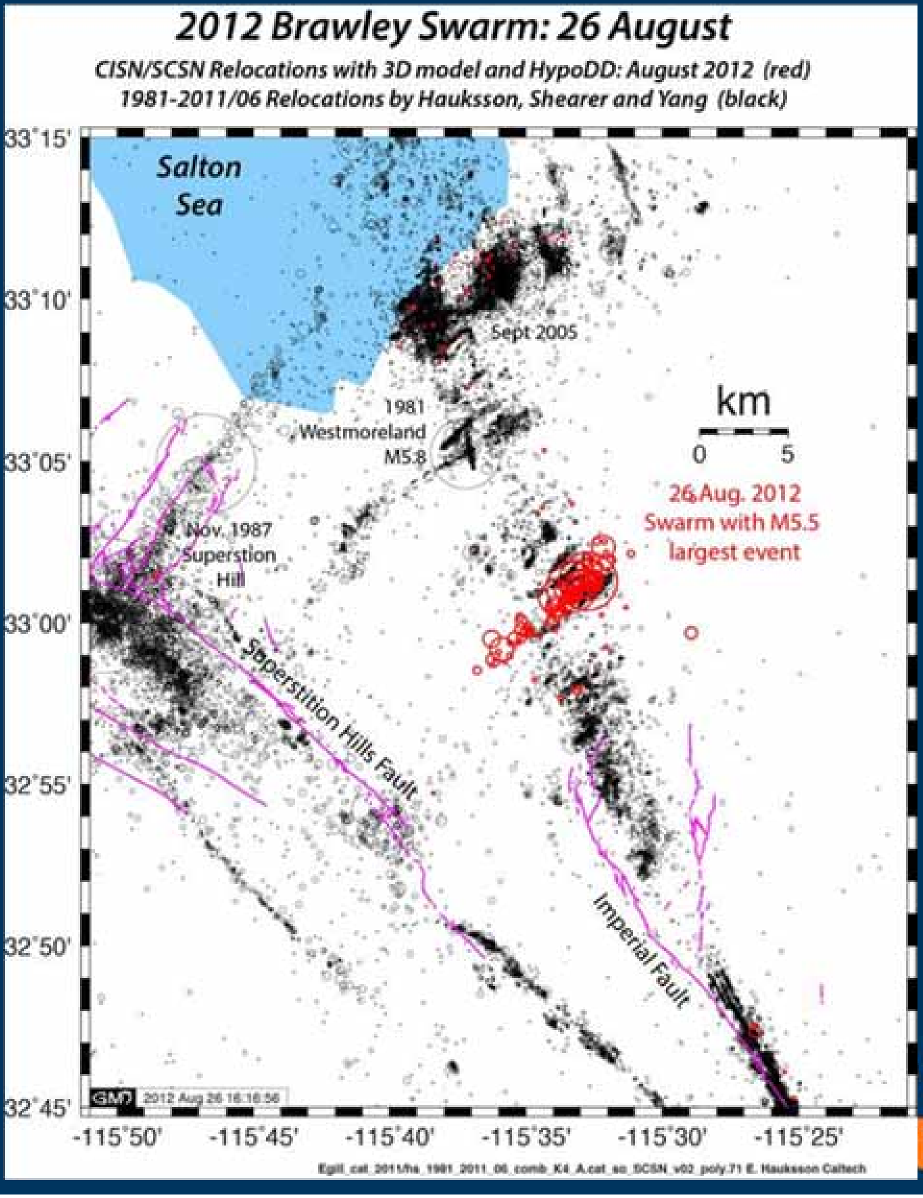
San Andreas – Its Our Fault



- California straddles boundaries between large plates of the Earth's crust
- The boundary where the Pacific Plate and the North American Plate meet in California is called the San Andreas Fault.
- The two plates are moving past each other at roughly 2 inches a year – about the rate that fingernails grow.
- As the plates move they build up stress. When this stress is suddenly released, earthquakes can occur.

Brawley Earthquake Swarm August 2012

- **Swarm** – sequence of many earthquakes striking in a relatively short time with no clear mainshock
- Close to 1,000 events greater than M1 recorded since 8/26 with largest being M5.3 and M5.5 on 8/26. Eight events between M4.0 and M5.0 first 3 days
- EQ faults work differently near Salton Sea than Los Angeles
- Last major swarm in 2005 (top M5.1) and larges swarm was in 1981 (M5.8). 1960's and 1970's with thousands of events
- No major fault in zone (M7 must have a fault at least 50 km long)

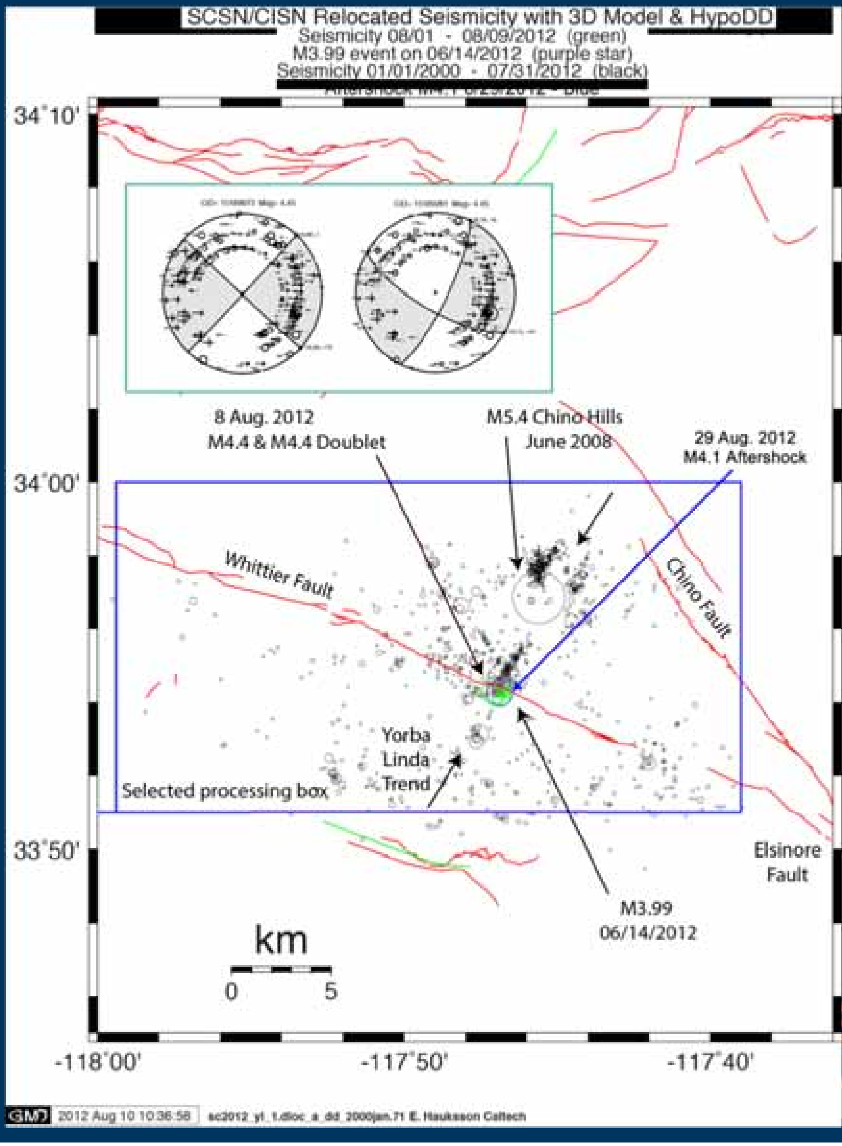


Yorba Linda Doublets
August 2012

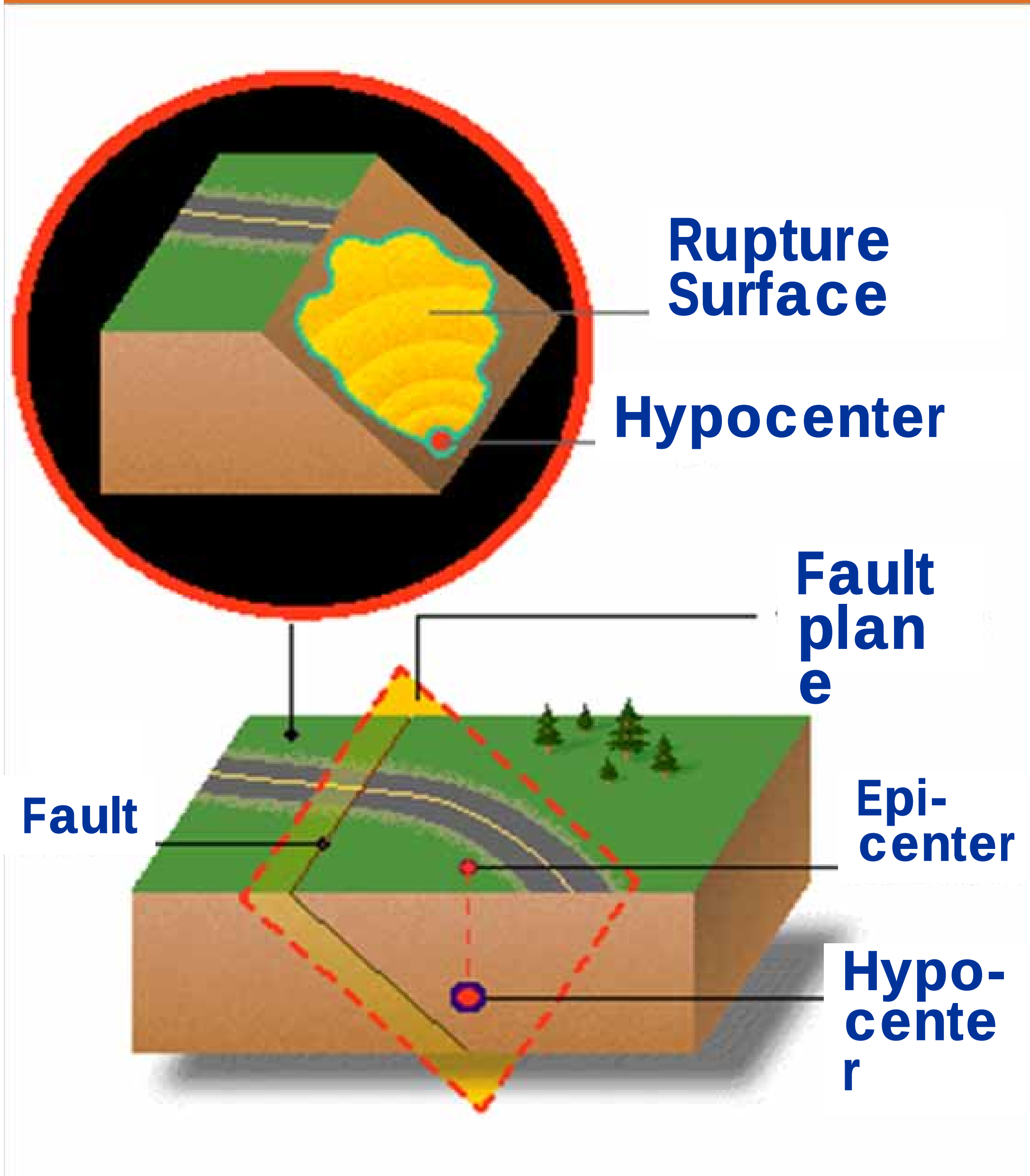
<u>Doublet</u> – pair of similarly sized Earthquakes that occur relatively Closely spaced in time and location

Yorba Linda Trend – area between Chino Hills and Yorba Linda

- June 2008 M5.4 Chino Hills
- Aug. 8 two M4.4's Yorba Linda
- Aug 29 M4.1



What Makes a Big Earthquake?



Every point on the rupture surface releases energy

The longer the rupture the more shaking lasts

A bigger fault rupture means a bigger earthquake

ShakeOut

Strike-Slip fault off-setting a road

San Francisco 1906 M7.8

Shift Happens

6 to 7 feet of vertical displacement in some areas

Shaking Damage Affected By:

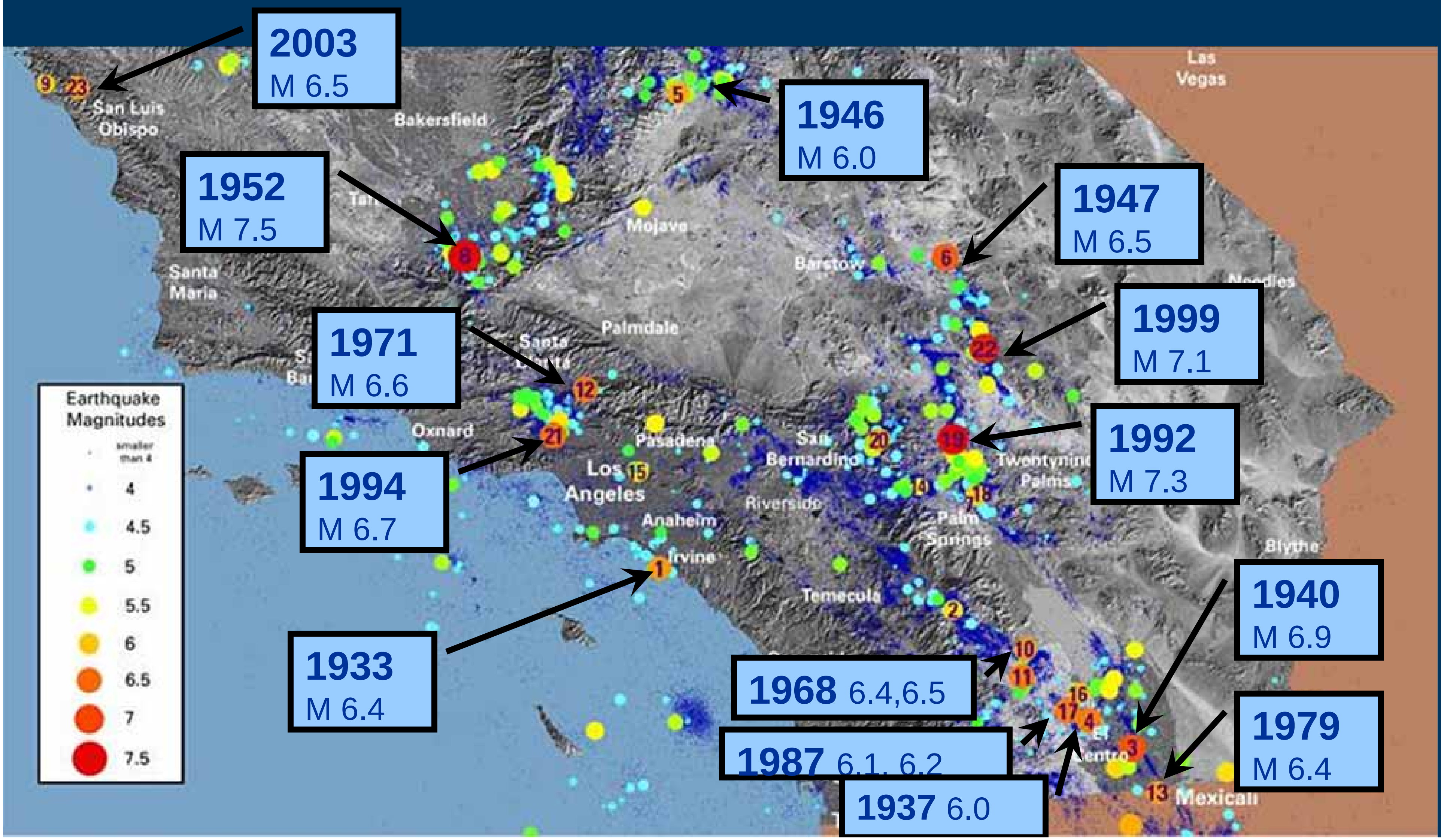
- Magnitude and duration of shaking
- Distance you are from the fault
- Directionality of the energy produced from the rupture
- Soil topography
- Quality of construction of the building
- Depth of the hypocenter

Over 30 earthquakes a day in southern California

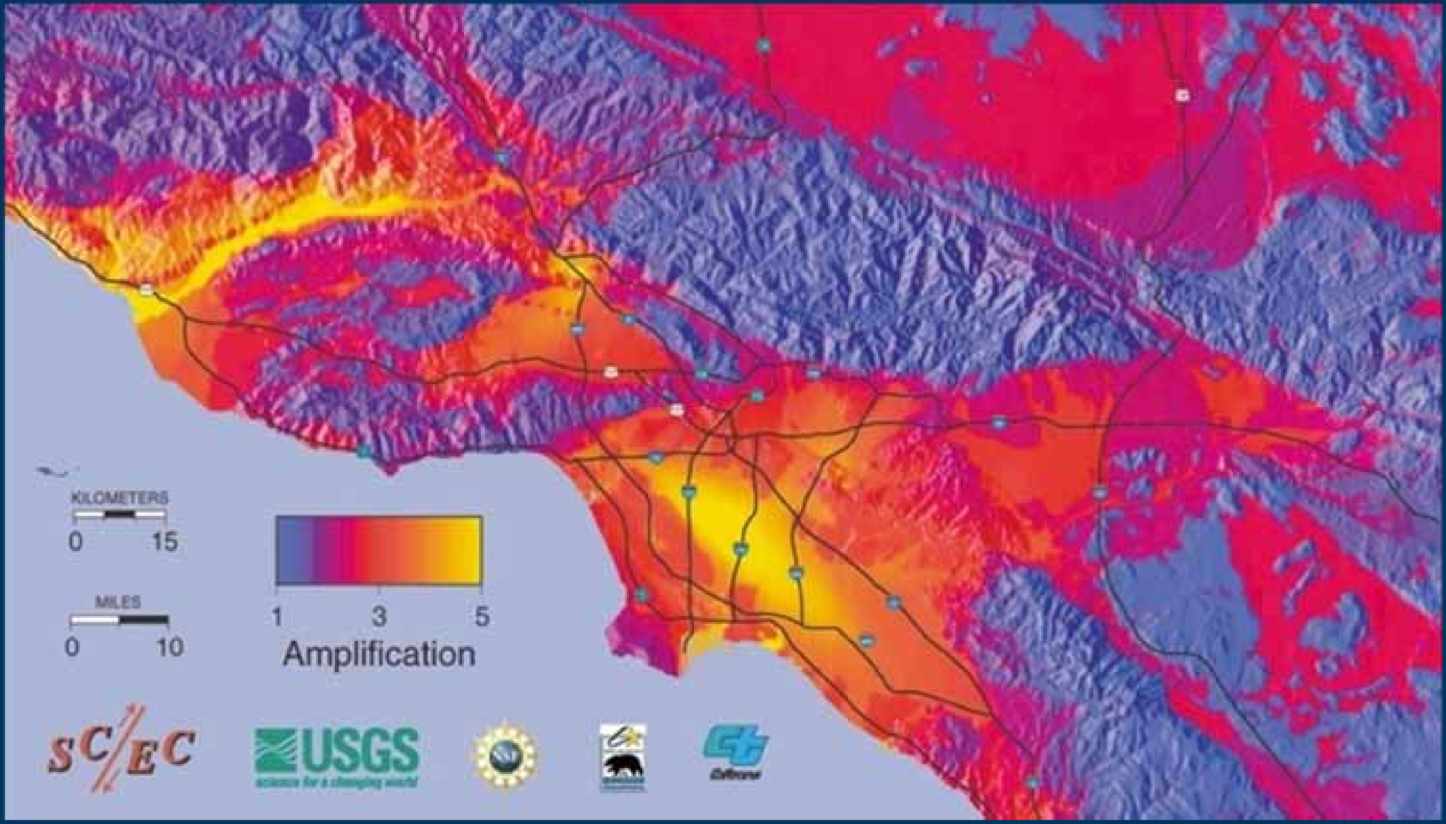
Magnitude 6.0+ on average every 5 years

Magnitude 7 every 30 years and M7.7 every 150 years

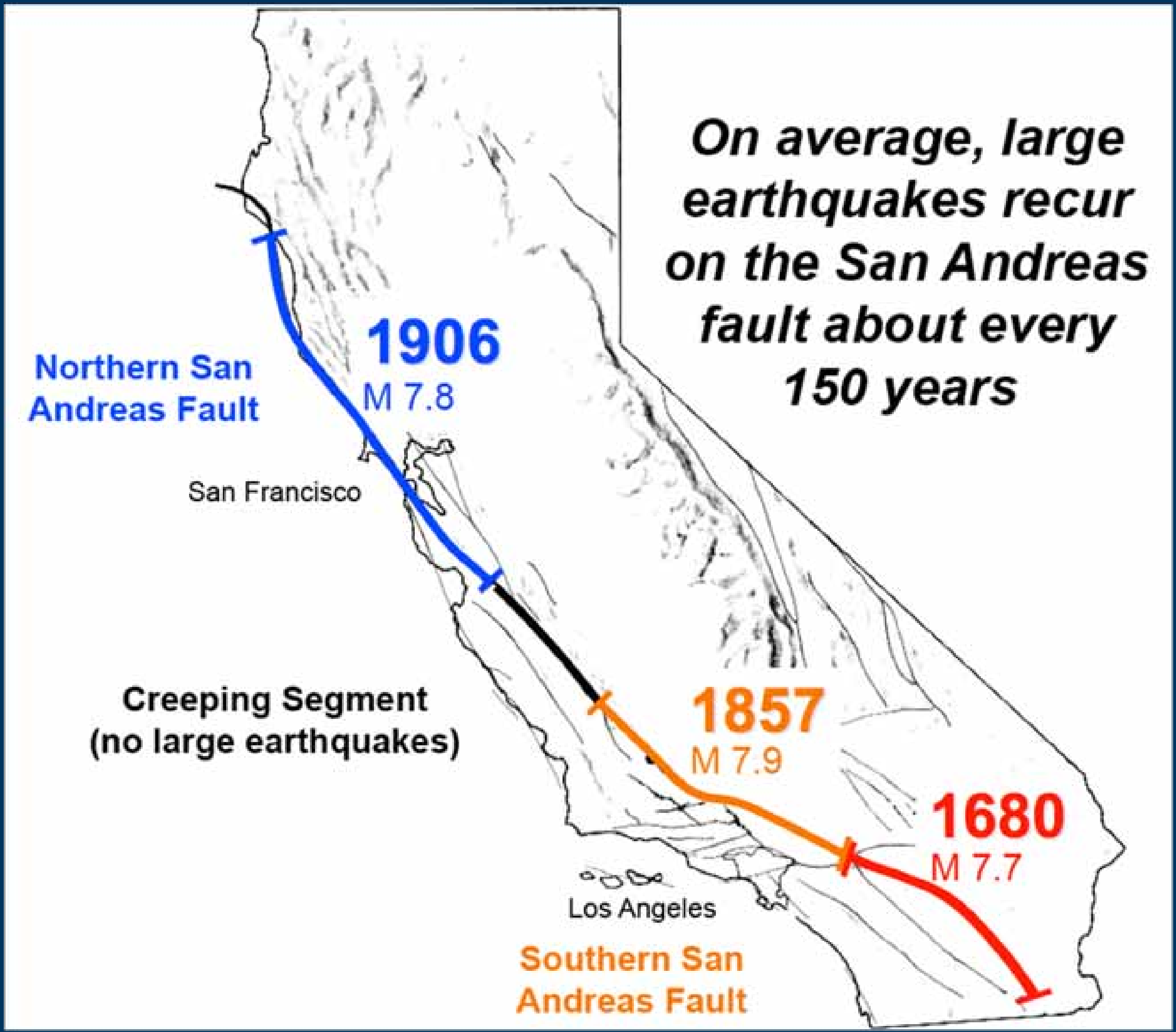
Note no earthquakes in last 76 years on San Andreas Fault Zone or Los Angeles...



Sediment-Filled Valleys Amplify Shaking



History of San Andreas Earthquakes



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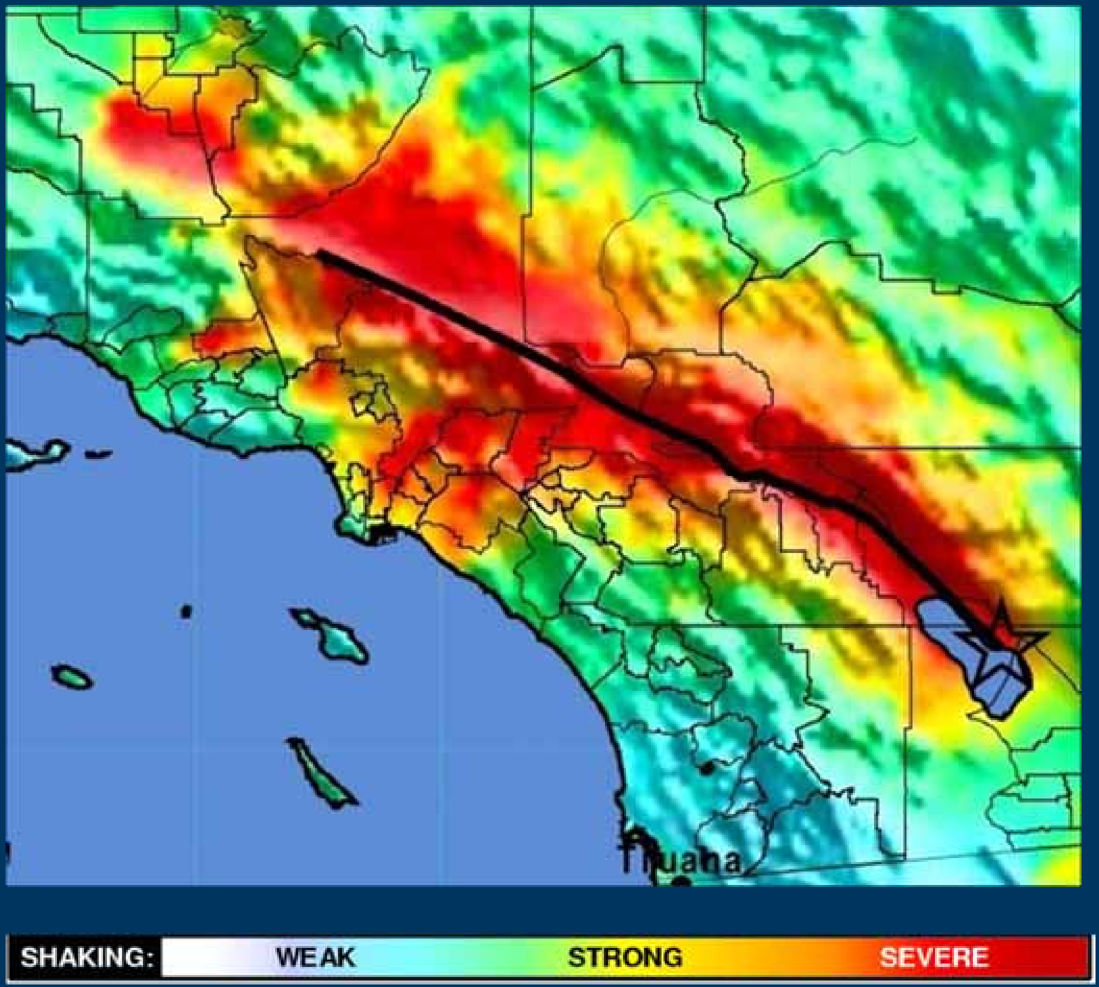
What Will the "Big One" be Like?

- Greatly affect 8 counties of So. California
- 300 km (180 mi) rupture
- Magnitude 7.8
- 100 seconds of fault rupture
- Ground shaking for over 2 minutes in many places!
- Disruption of critical lifeline infrastructure (freeway, internet, power and gas lines) along surface rupture; Slip of 3-4 meters at Cajon Pass (I-15)



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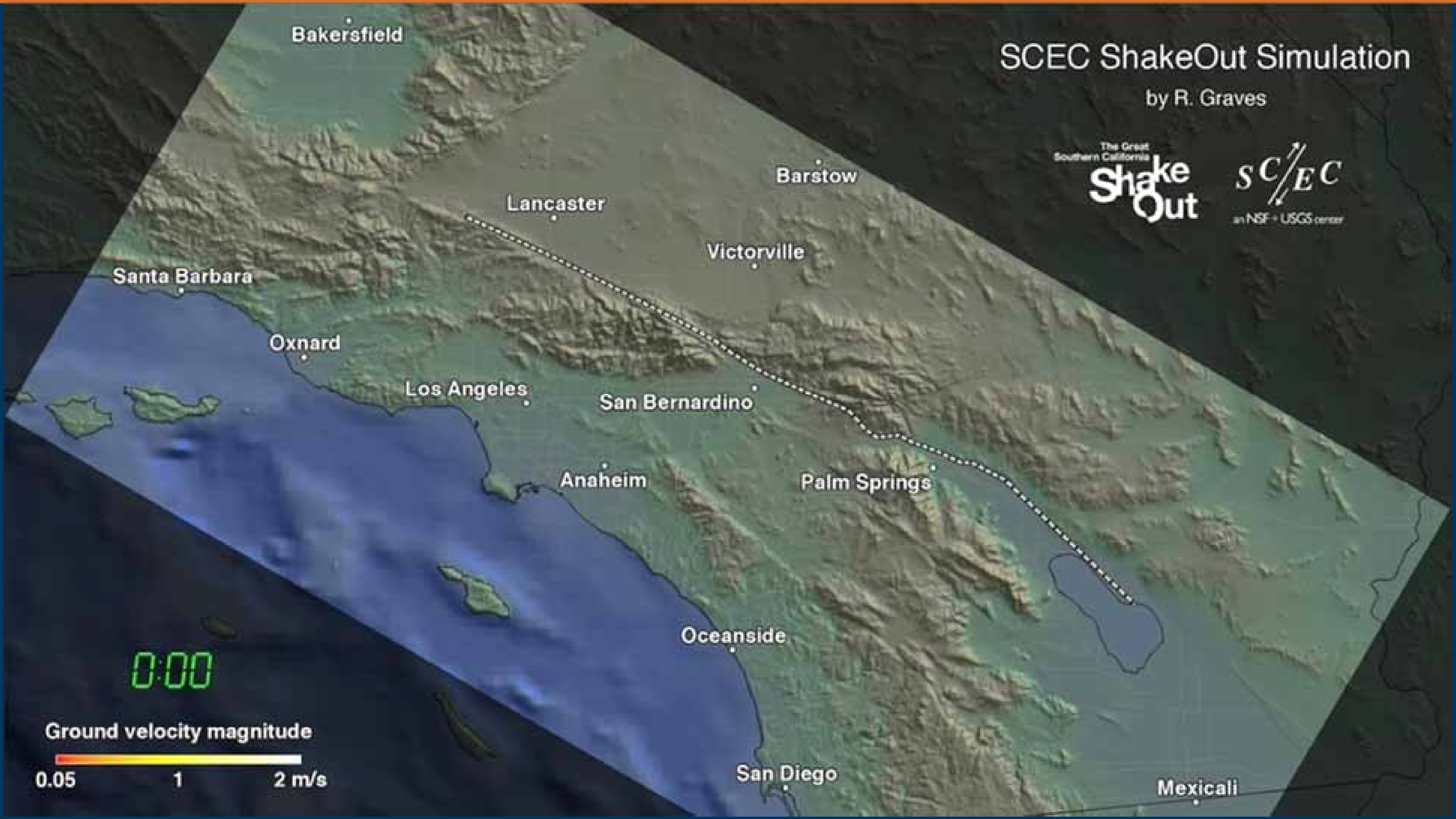
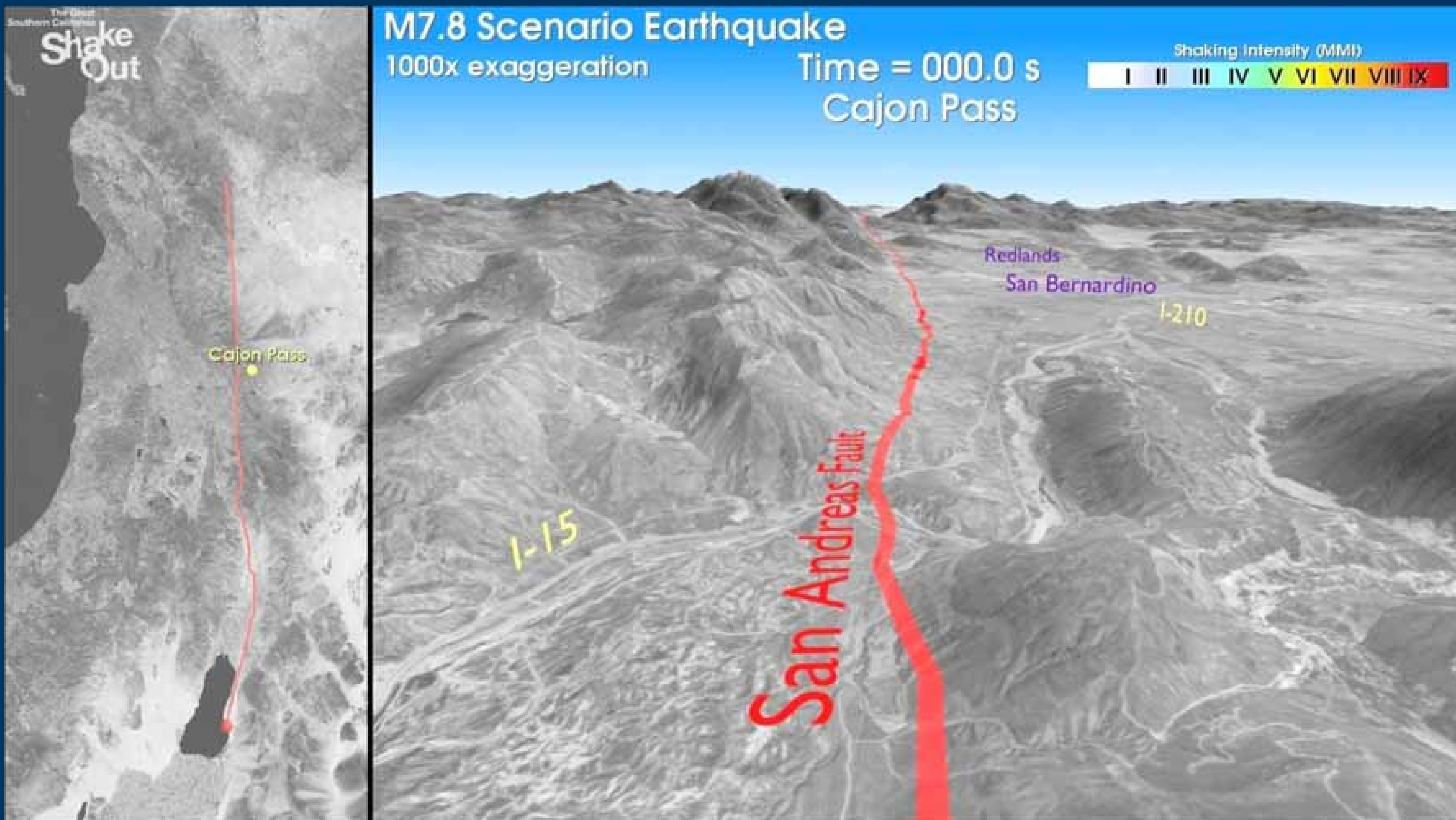
Shaking of Long Duration



(Northridge strong shaking lasted 7-15 seconds)



The Great Southern California
ShakeOut
Cajon Pass
M7.8 Scenario Earthquake
1000x exaggeration
Time = 000.0 s
Cajon Pass
Shaking Intensity (MMI)
I II III IV V VI VII VIII IX
Redlands
San Bernardino
I-210
I-15
San Andreas Fault

ShakeOut

Shakeout Scenario “Disaster Equation”

Widespread Strong Ground Shaking

+ Shaking of Long Duration =

300,000 buildings significantly damaged

Widespread infrastructure damage

$213 billion damages

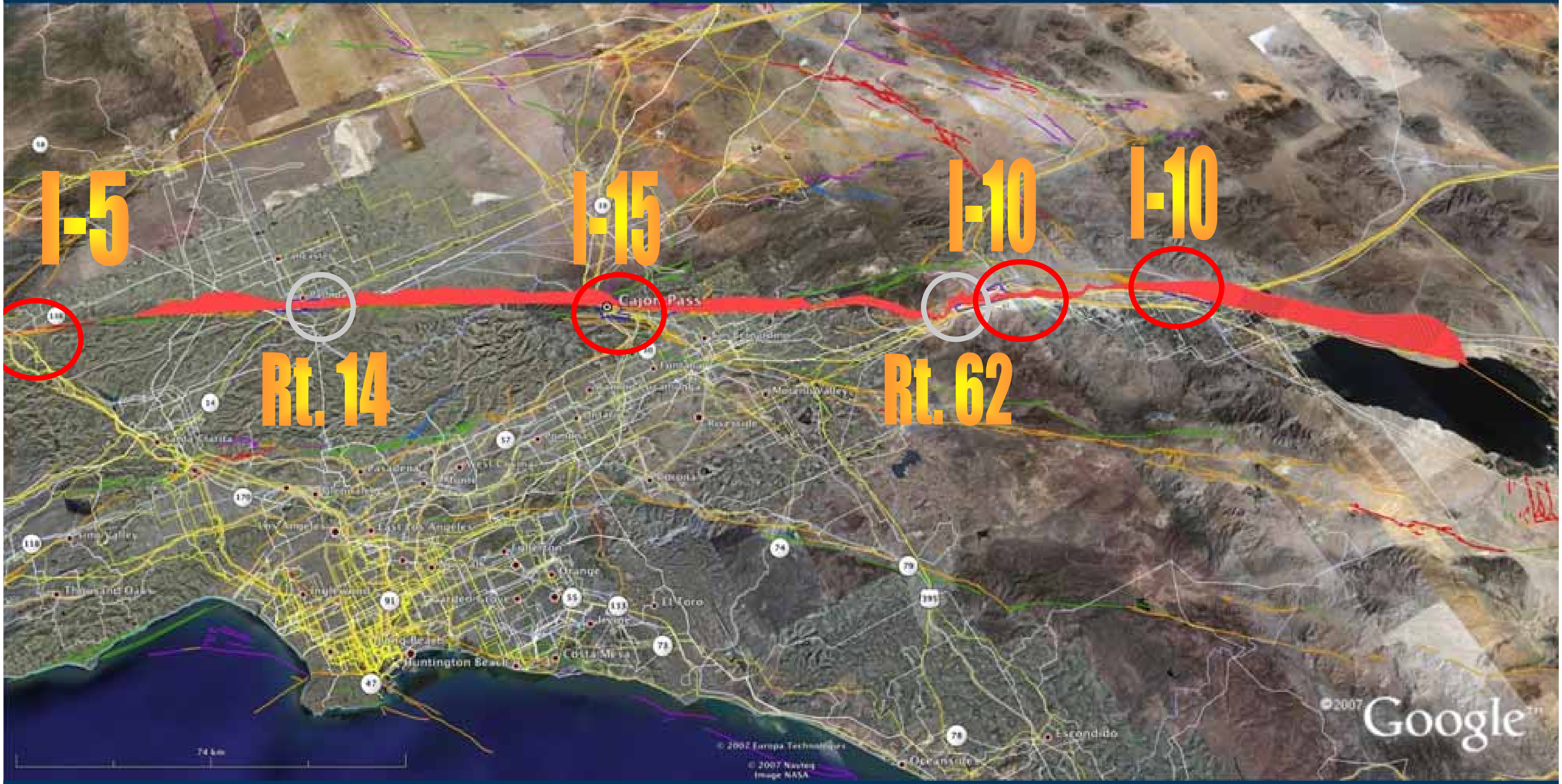
270,000 displaced persons

50,000 injuries

1,800 deaths

All lifelines Cross San Andreas Fault

Caltrans freeways (and major highways) fault crossings



Water supply

- Aqueducts & tunnels cross the fault in several places
- Also sensitive to landslide & liquefaction
- Older pipes damageable by shaking, liquefaction, …
  - Some LA water & sewer pipe is 100+ yr old
- Groundwater supply needs power, pumps, tanks, and other damageable equipment

1971 San Fernando Earthquake

1994 Northridge Earthquake

Utilities

Electric Power

- Immediate loss of power throughout region
- Collapse of some high-tension towers, damage to transformers on overhead poles
- Generating plants taken offline for inspection

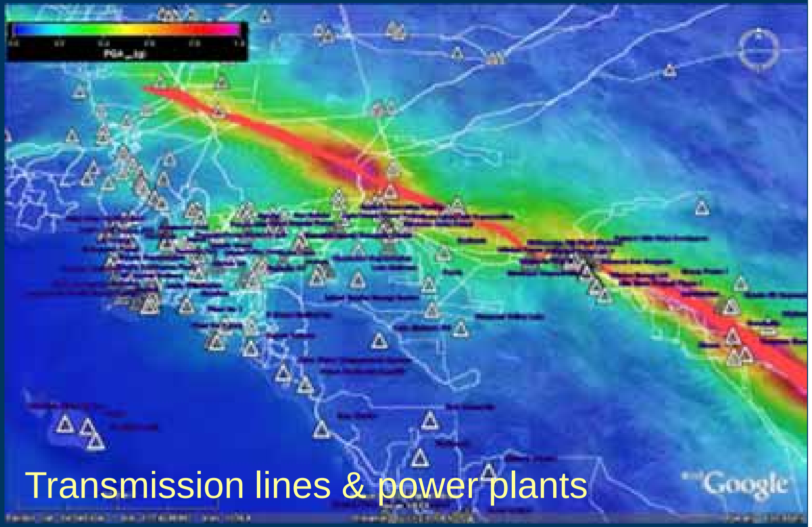
- 30-50% of service restored in 3 weeks
- 75-90% restored in 1 – 4 months
- ~100% restored within 18 months

Phone Systems Overwhelmed

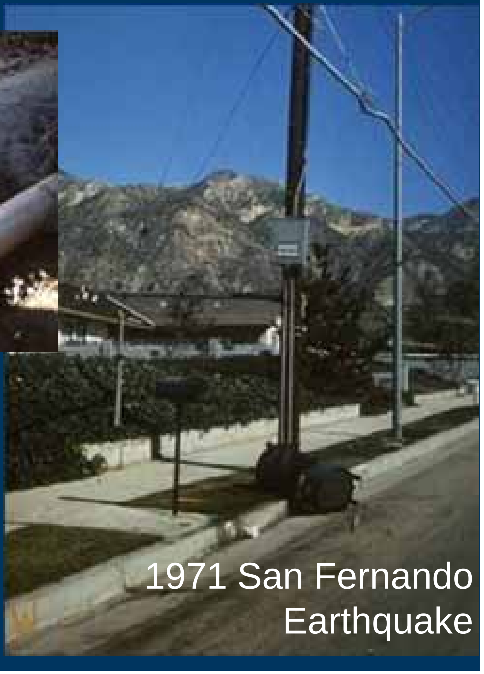
- Cell towers unregulated so damaged
- Fault offsets internet lines
- All service out for first day; most restored within 2 weeks

Gas outages widespread

- 2 to 4 weeks with 60% restored in pockets with light-ups



Transmission lines & power plants


1971 San Fernando Earthquake

Building Damage

- 300,000 significantly damaged (1 in 16)
  - repairs cost at least 10% of replacement cost
- 45,000 complete losses (1%)
- Unreinforced masonry buildings
  900 destroyed; loss of life near fault not retrofitted
- Older concrete buildings (most dangerous-rebar)
  - 50 collapses
  - 5,000 – 10,000 people in collapsed buildings
  - 100 red tagged buildings
- Woodframe buildings (most numerous)
  - 175,000 wood buildings significantly damaged (1 in 25)

1994 Northridge CA

1992 M7.1 Mendocino

Long Beach 1933

Transportation Disruption

- Repairs will cause months of delays

  (Causes delays in repairing lifelines)
- No highway bridge collapses(Caltrans)
  - Not true for local jurisdictions' bridges
- Roads impassable due to:
  - Damage & debris
  - Landslides & Fault Rupture
  - Gridlock:
    - Traffic signals out
    - Vehicles abandoned in place

Fire Following Earthquake

- Earthquakes cause fire disasters
  - Numerous simultaneous ignitions
  - Degraded fire-resistive building features
  - Reduced pressure in water mains
  - Saturated communications
  - Traffic impacts
  - More fires than firefighting capabilities…

- Study findings
  - 1,600 ignitions requiring a fire engine
  - 1,200 exceed capability of 1st engine
  - Northern Orange County & LA Basin: conflagrations destroy 100s of blocks
  - 200 million square feet burnt
    ~ 1.5% of total building stock
  - No Santa Ana winds… *not worst case*
  - *900 of the 1,800 casualties are from fire*

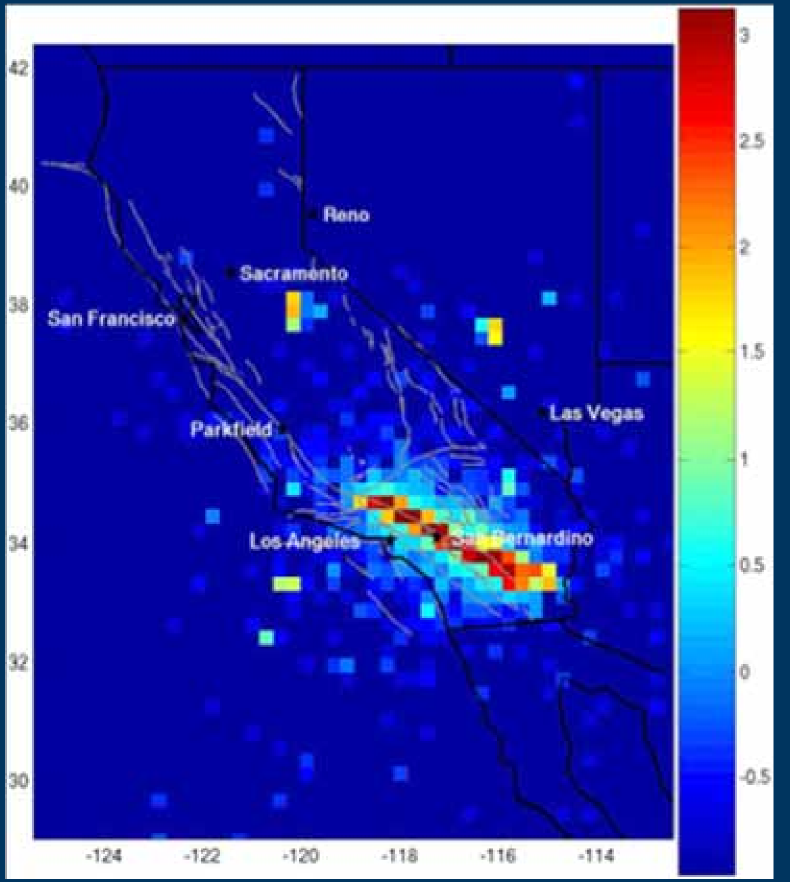
Fire risk greatest in areas with strong shaking and densely-packed wood buildings; many such areas in LA Basin and northern OR Counties

Where's the Water??

And that does not include Aftershocks

- Damaging earthquakes may occur for *decades* after a magnitude 7.8
  - Some may be more destructive than the mag 7.8 mainshock
  - Some will be larger than Northridge
  - Will occur over wide area

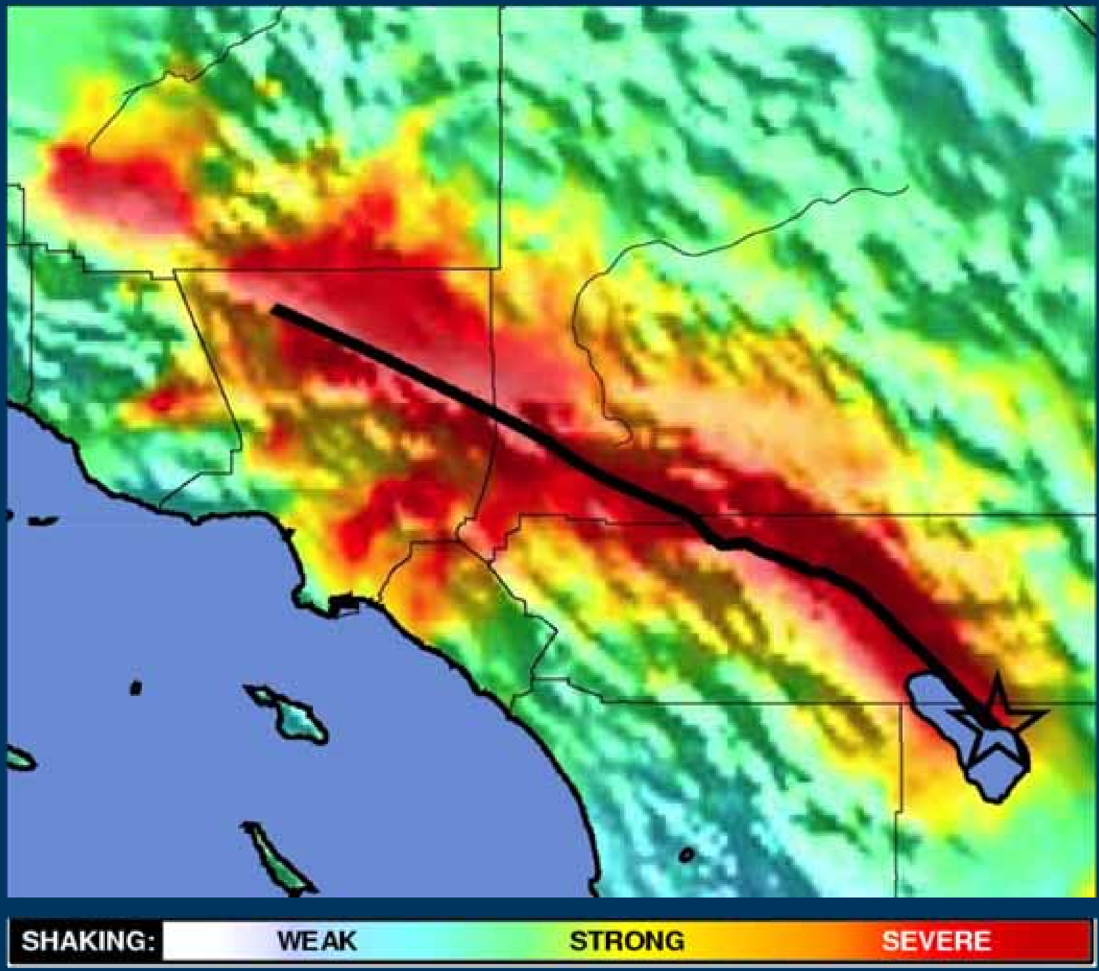
- Simulations of realistic aftershock sequences for Scenario
  - Four aftershocks will be used in Golden Guardian exercises:
    - Mag 7.2 ruptures through Inland Empire toward Pasadena
    - Mag 7.0 ruptures from Salton Sea into Imperial County
    - Mag 5.7 with epicenter in Rialto
    - Mag 6.0 disrupts newly restored rail lines in Cajon Pass



Distribution of aftershocks in Scenario simulations

Regional Catastrophe

- A regional catastrophe is so big you can't drive away from the disaster
- Emergency services will be stretched beyond their ability to respond
- Together we can prevent a disaster from becoming a catastrophe



ShakeOut

Haiti	Mw 7.0
Chile	Mw 8.8
Baja	Mw 7.2
Japan	Mw 9.0

Not IF but when…

ShakeOut

What we do now,

before the earthquake,

will determine

what our lives are like after

Earthquake Response will not be there for us

Are Californians Prepared?

March 5, 2010 Study by UCLA:

- Less than 20% have prepared their homes
- 40% have sufficient water
- Less than 20% have earthquake insurance
- 80% have first aid kits, flashlights, batteries b
- 40% have no family emergency plan
- Less than 20% have a neighborhood plan
- Less than 50% have dust masks; rescue tools; supplies in car or work or CERT or first aid trained

Seven Steps to Preparedness

Prepare

Protect

Recover

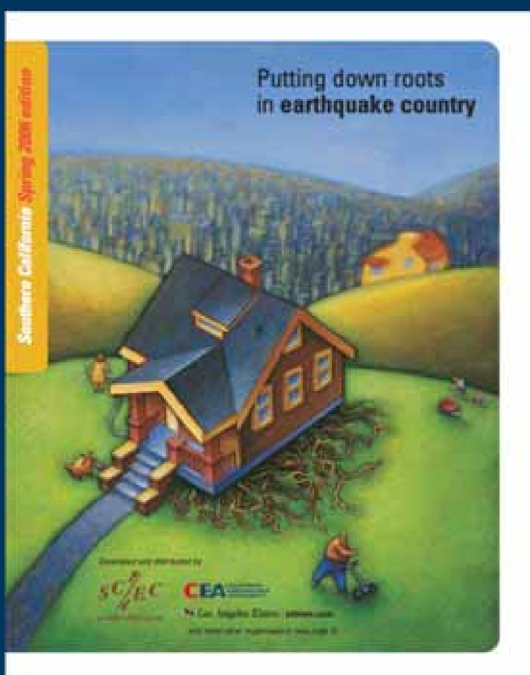
Seven Steps Toward Peace of Mind

Identify Potential Hazards in your Home and Begin to Fix them

#1

BEFORE

Secure Your Space!



www.DareToPrepare.org

ShakeOut

Non-structural damage – Secure Space

Secure Your Stuff…

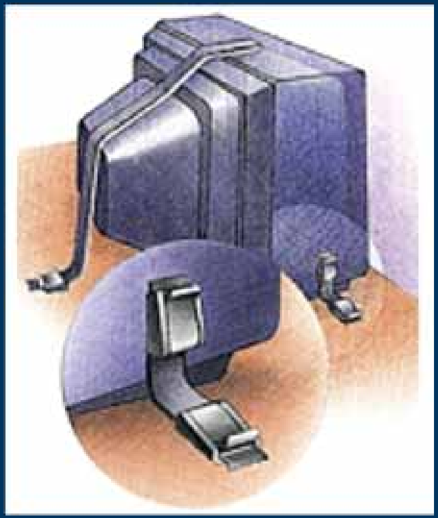
www.earthquakecountry.org

- Hot water Heater
- Appliances
- Cabinets
- Tall furniture/bookcases
- Tv's, computers, monitors
- Vending machines
- Wall hangings
- Generators
- Ceiling fans

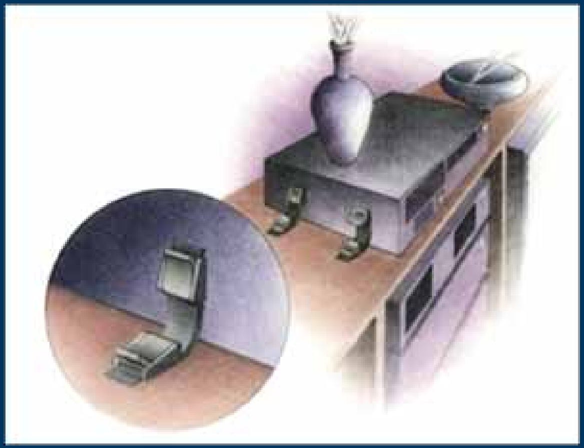



Secure Your…

TVs and electronics



Peel and press nylon straps and buckles



#1 BEFORE

www.DareToPrepare.org

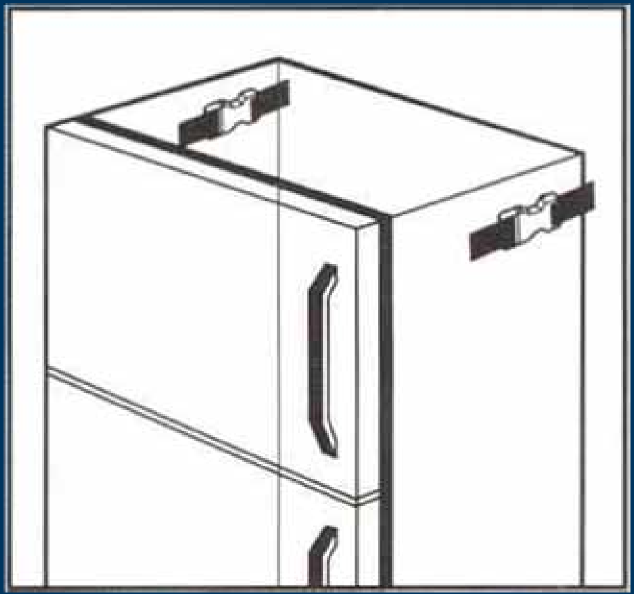
ShakeOut

Secure Your…

Refrigerator

Refrigerators are extremely heavy, and most are on wheels. They may crush someone if they move and tip. Secure refrigerators to the wall studs at top (and preferably bottom as well)

Secure refrigerator with flexible woven straps



Use latches to keep doors closed and contents from spilling out and spoiling

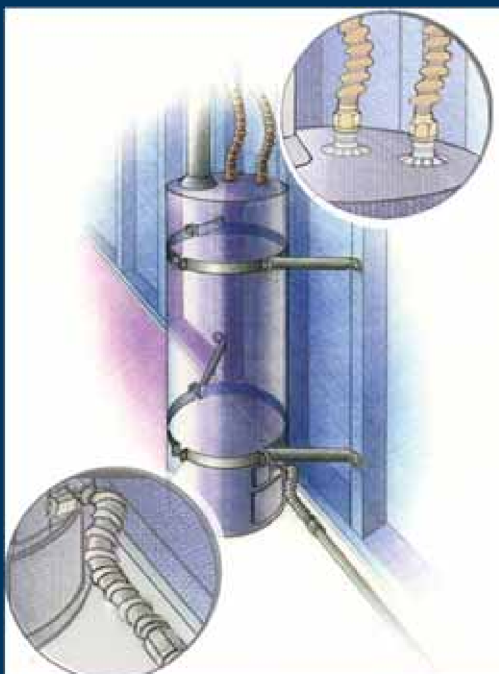
#1 BEFORE

www.DareToPrepare.org

ShakeOut

Secure Your…

Gas Appliances



Replace rigid gas connections to water heaters and other gas appliances, with flexible stainless-steel gas connectors.

Secure the appliance to wall studs.

Backup Plan: Keep extra flexible connectors in case of breakage and plumbers being unavailable.

#1 BEFORE

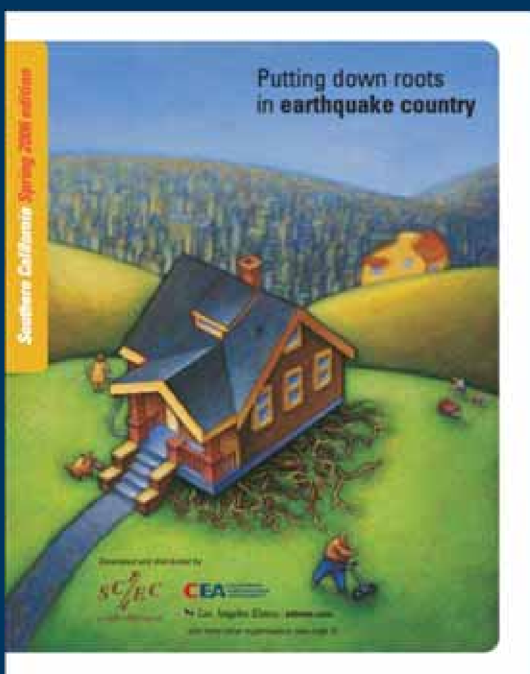
www.DareToPrepare.org

ShakeOut

Create A Disaster Plan

#2

BEFORE



www.DareToPrepare.org

ShakeOut

Employee/Family Emergency & Communication Plan

Work and Home…

- Evacuation and meeting place

  open space, electrical wires

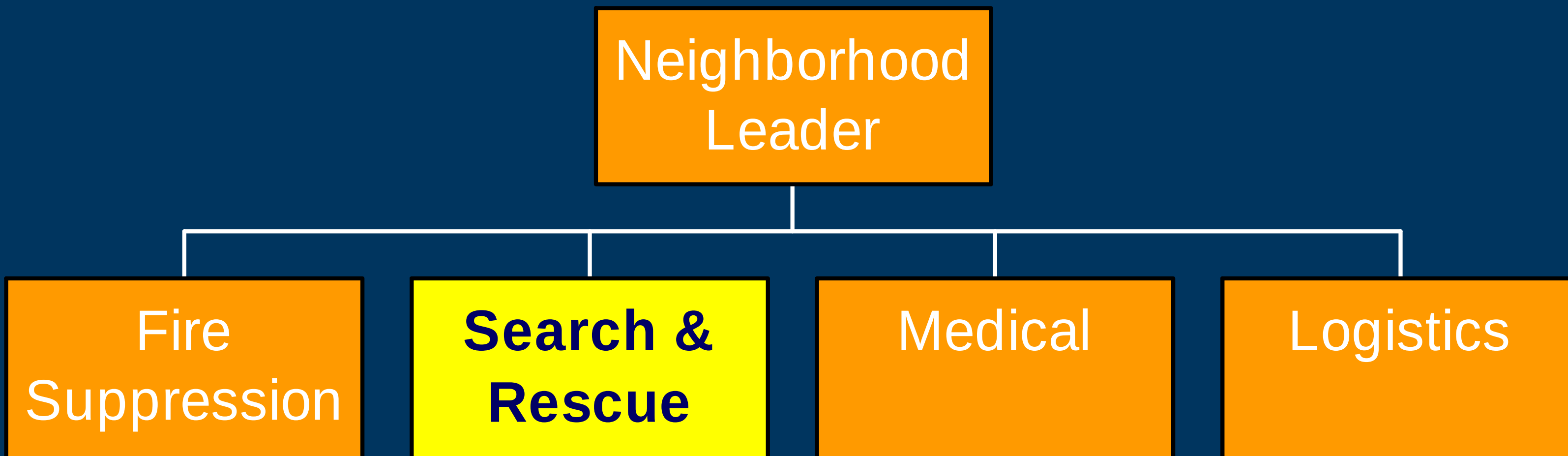
- Out of state contact person
- Location of emergency supplies
- Copy of important documents/info
- Shelter in place

  work – employees have supplies

  home – animals, family plan, supplies

Neighborhood Organization

You are only as prepared as your next door neighbor

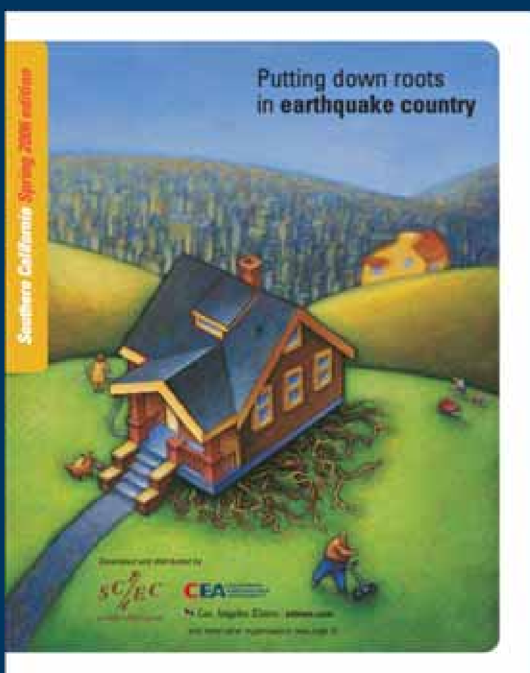


- CERT Training
- Assess needs, assets, hazards, resources(ham radio, S & R, at home
- Develop an action plan and communication plan
- Map your neighborhood

Prepare a Disaster-Preparedness Kit

#3

BEFORE

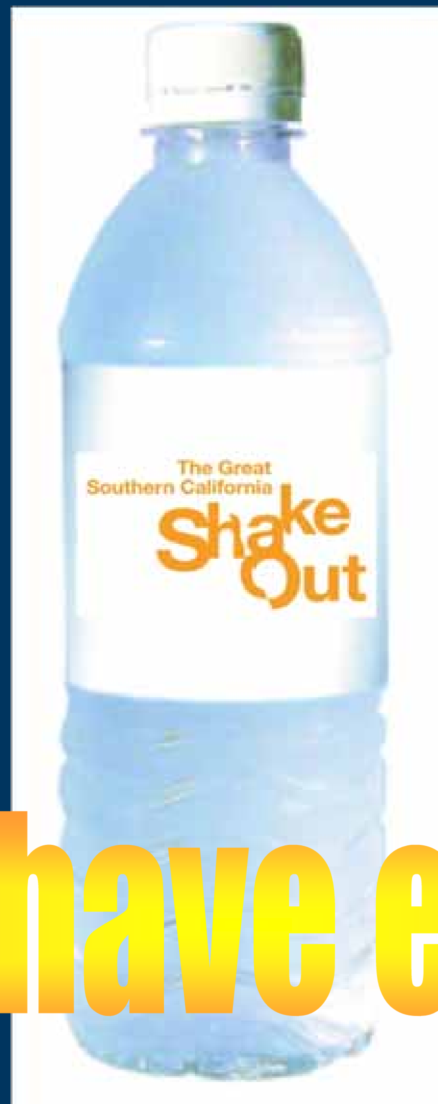


Home, Car, Work/School

www.DareToPrepare.org

Drinking Water:
1 gallon per person, per day for at least 7-10 days

Family of 5:
35 gallons



Need plenty at work, in the car and at home

Do you have enough?

ShakeOut

Emergency Kits - Car, Home, Work

CAR and Evacuation:

water, shoes, extra clothes, flashlight, batteries, radio, whistle, food, jacket, umbrella, paper/pencil, important documents (license, ins. Info, banking info., contact numbers), toilet paper, medication, extra glasses, etc…..

Emergency Supplies 7-10 days

Flashlight, batteries
Hand crank radio
Local map
Evacuation pack
Water – 1 gallon per person per day
Batteries
First aid kit
Sunscreen
Pocket knife
Watch/clock
Food
Personal hygiene items
Toilet paper
Medication/glasses
Can opener
Whistle
Fire Extinguisher
Paper pencil

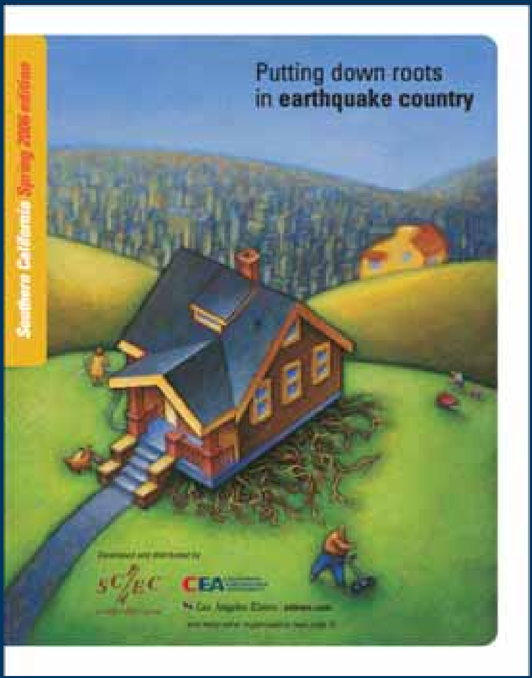
Work gloves
Comfort items: candy bars, books, playing cards, games
Hard hat
Emergency tent
Dusk mask and googles
Crow bar
Rope
Hammer/folding shovel
Animal food – rabies certificate;leash;toys
Sleeping bag or blankets

Keep gas tank ½ full
Have $1 bills
Emergency contact outside area
Copy of all important documents
Shoes/flashlight under bed
Extra set of keys

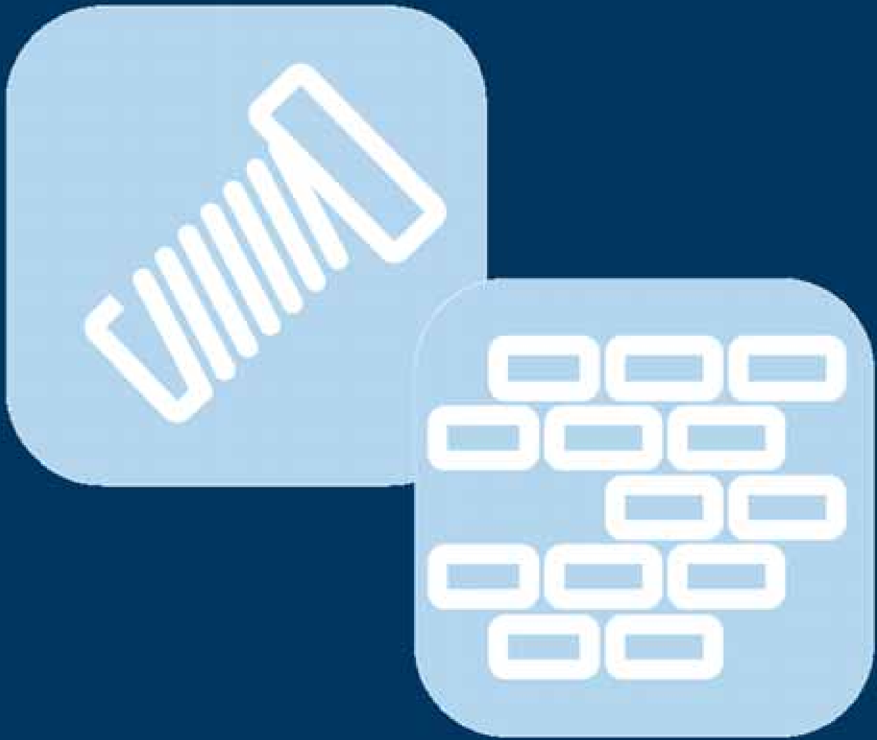
Identify Your Building’s Weaknesses and Begin to Fix them

#4

BEFORE



Know Your Building



www.DareToPrepare.org

ShakeOut

Know and Secure Your Building

- Where are the safe places to go to
- Slab Floor – bolt to the foundation
- Crawl Space – reinforce cripple wall
- Age and construction of building – retrofitted
- Identify safe and potential damaging ares
- Work with building manager
- Consult outside experts if you need to
- Strengthen and repair potential hazards
- Structural and non-structural hazards
  - outdoor signs, facades, items that may block exits
  - Items that might fall on people exiting
  - Fire sprinklers

Building Collapses

Soft story damage

Public Assembly

Parking Structure

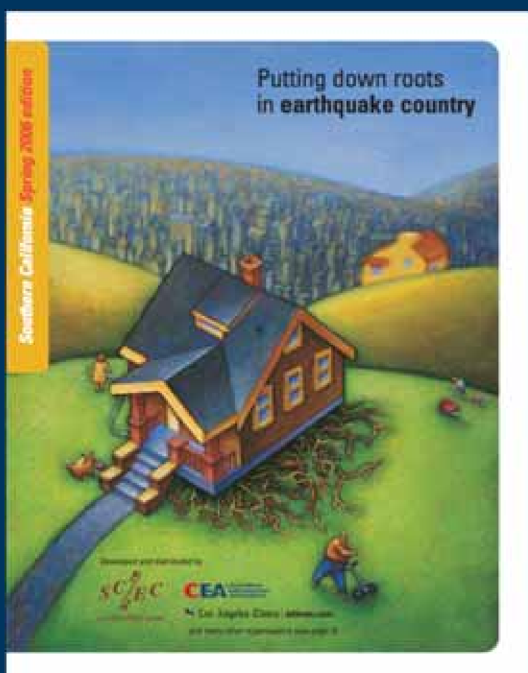
Masonry Buildings
Reinforced and Unreinforced

Lean – To Collapse

Drop, Cover, and Hold on

#5

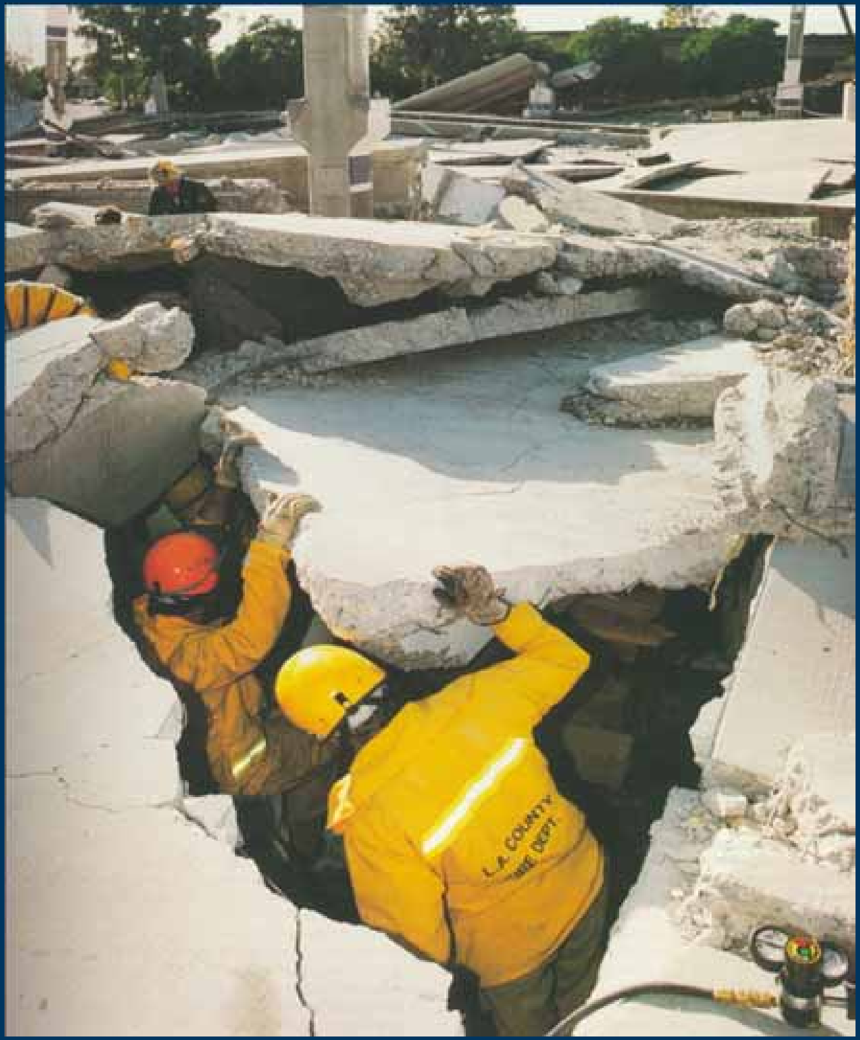
DURING EARTHQUAKE



www.earthquakecountry.info/dropcover
holdon

ShakeOut

Drop, Cover, Hold On Works!



Do not run outside or go into a doorway

Do not do triangle of life

Haiti school desks provided protection

Non-structural damage is the risk

Non-structural damage is not included in state building codes.

Strict laws mandate how schools and buildings are built but not seismic inside them

What to do during an earthquake

- Drop, Cover and Hold On
- Bed: Stay there and protect your head
- High-rise: Drop, Cover, Hold-0n away from windows, no elevators
- Outdoors: Move into clear area and DCHO
- Driving: Pull over to side of road – set brake
- Stadium: Stay at your seat and protect head/neck
- Do not go into a doorway or do triangle of life

- Have $1 bills and never less than ½ tank of gas
- If you smell gas turn off the gas valve
- Have an emergency plan within your family
- Neighborhoods should have a plan and drill the plan
  - animals; disabled; medication; search/rescue items; emergency contact info; insurance cards
- Be CERT or PERT trained

DO NOT RUN OUTSIDE

ShakeOut

Tsunami

- Tsunami is sometimes proceeded by a rise or fall of water level or strange Bubbling in the tidal areas. Head for higher ground

- Not always a large wave but a rise in sea level and surge of water

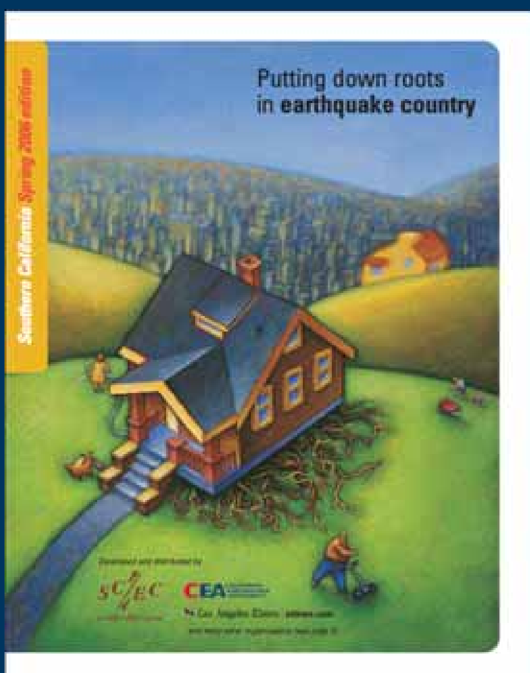
http://www.consrv.ca.gov/cgs/geologic_hazards/Tsunami/Pages/About_Tsunamis.aspx

Check for Injuries and Damage

#6

AFTER

Join your local
Community Emergency
Response Team (CERT)!
www.cert-la.com



www.DareToPrepare.org

ShakeOut

Gas Valves

- Place a shut off wrench near the main gas line and learn how to turn it off.
- Do not turn it back on yourself – check with the Gas Company for instructions, including relighting pilot lights.
- Automatic Gas Shut Off Valves are a good investment.

#1 BEFORE

www.DareToPrepare.org

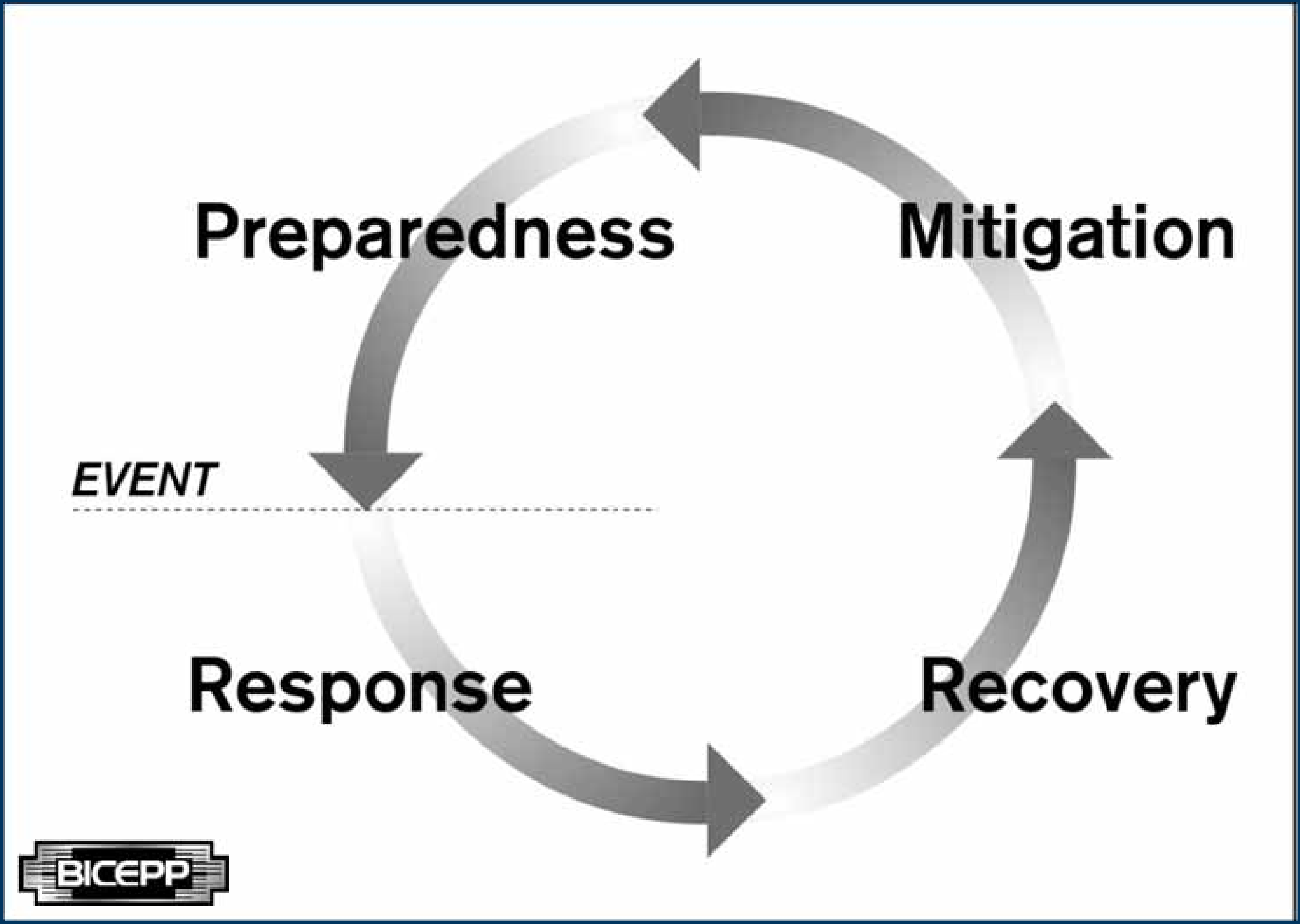
Helping Others Be Prepared…Protects You
You are only as prepared as your neighbor

What Leads to People Getting Prepared?

- They see and hear consistent, frequent, multi-media, and multi-source information about what to do
  - “Sell” earthquake preparedness like Coca Cola sells Coke.
- They see others like themselves getting prepared
  - “Monkey See, Monkey Do”
- They talk about preparedness with people they know
  - And then think it’s their idea
- Focus on consequences and how to avoid them
  - Don’t just scare people!

Businesses Need to Have A Plan and Drill their Plan

Four Elements of Emergency Management

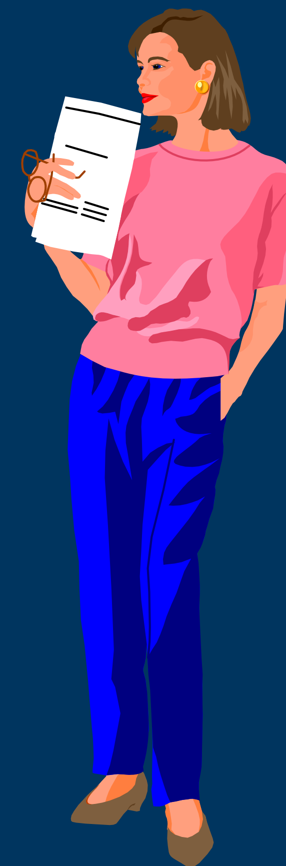


What is a Business Impact Analysis? (BIA)

- In-depth analysis of your business
- Means of systematically assessing the potential impacts resulting from various events or incidents
- Identifies known and hidden costs
- Raises awareness within your organization
- Identifies priorities
- Requires attention to detail

Your Business Plan Must Include Prepared Employees

- Family Preparedness Plan
- Know where Emergency Supplies & Equipment are kept
- Up-to-date contact information
- Additional Training Opportunities (CERT-Local Fire Dept.)
- Drills
  - Evacuation
  - Drop, Cover, and Hold on



DRILL YOUR PLAN

ShakeOut Created as an Opportunity to Drill your Plan

www.ShakeOut.org

Preparedness Resources

- www.earthquakecountry.org
- *Putting Down Roots in Earthquake Country*
  - Includes "Seven Steps to Earthquake Safety"
  - Online to read, download, or order free printed copies
  - So. Cal. English & Spanish
  - Bay Area (also multi-language special versions)
- *North Coast: Living on Shaky Ground* (similar content)
- *7 Steps to an Earthquake Resilient Business*
- www.Terremotos.org

RESOURCES

www.shakeout.org

www.earthquakecountry.org

www.bicepp.org

www.ready.gov

ShakeOut

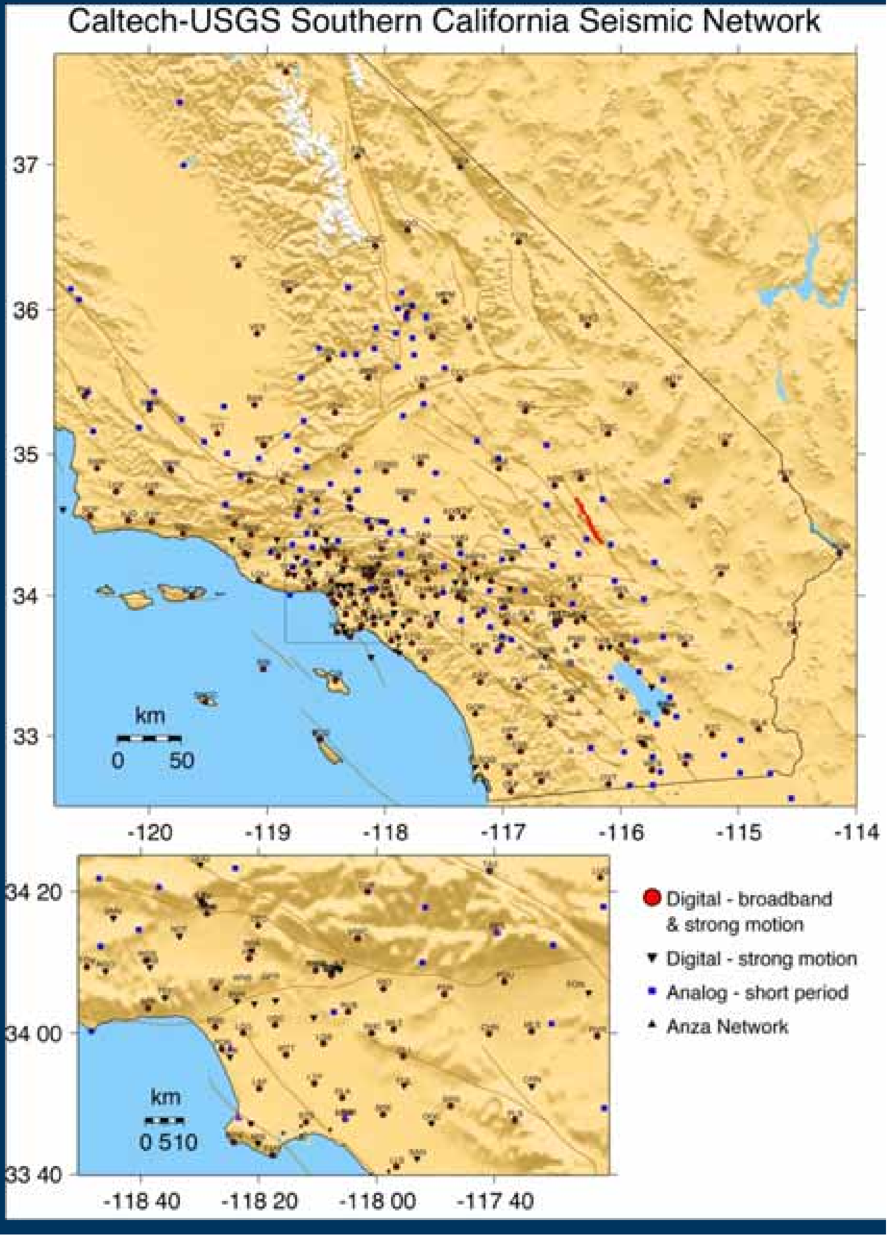
Utilize Earthquake Tools for quick response decisions and reducing losses

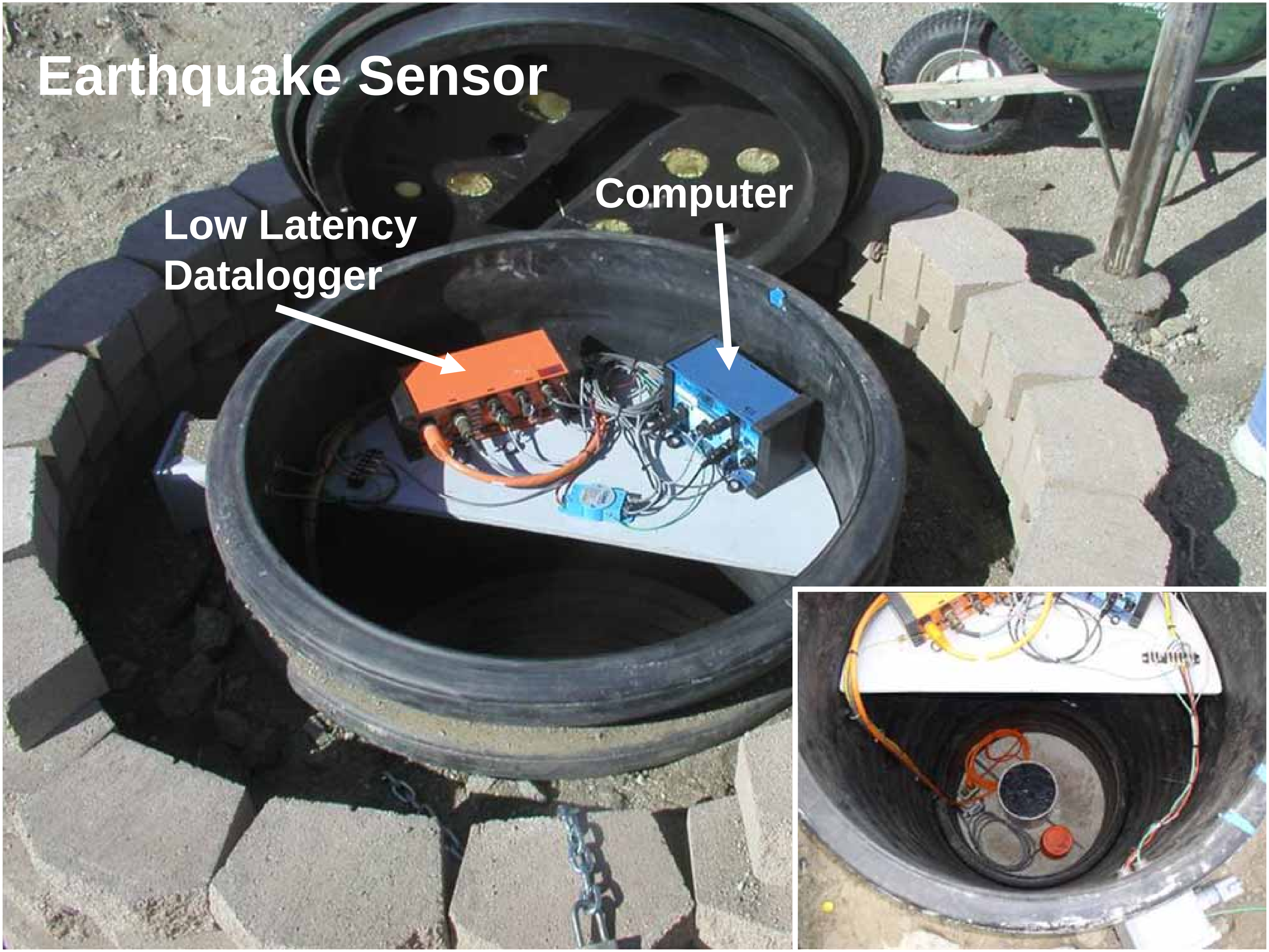
SCE/Caltech Collaboration

Modern Seismic Network

- ~360 Seismic Stations
- ~60 stations from partners
- Data communications
- Data Acquisition & Processing
- Real-time notification
- Post-processing
- Archiving/ SCEDC
- Data exchange with other networks

30 seismic stations at Edison substations equipped with professional grade seismometers and strong motion sensors



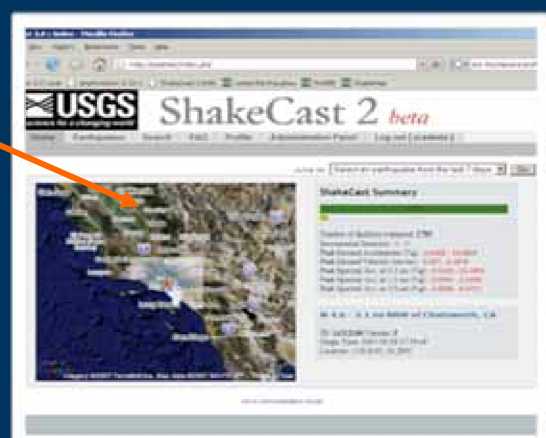

Earthquake Sensor
Low Latency
Datalogger
Computer

Fast, Diverse Data Telemetry

Products from the California Integrated Seismic Network (CISN)

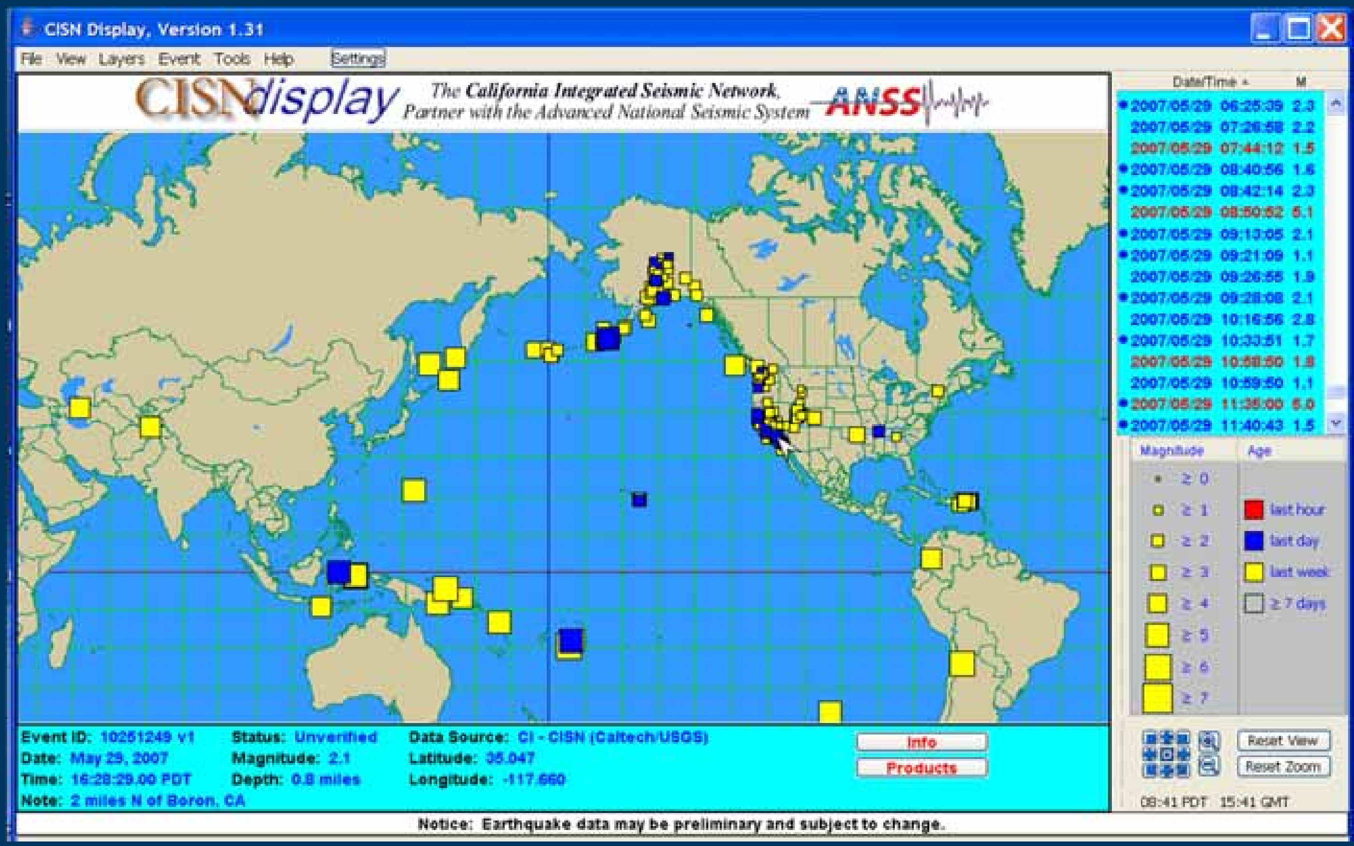
www.cisn.org

- ShakeMovie
- ShakeMap
- CISN Display
- ShakeCast
- And more…



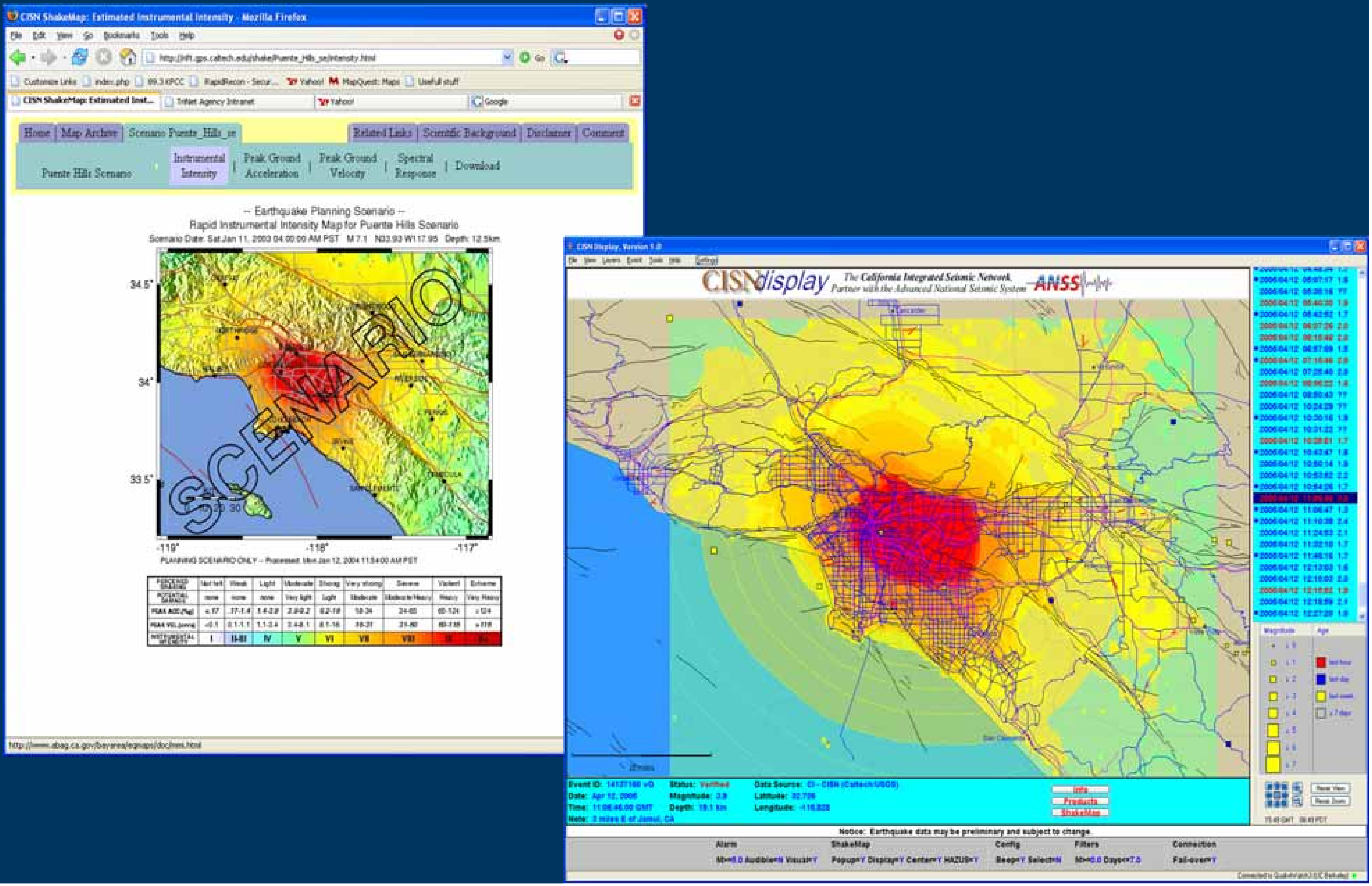
CISN Display

- Real-time earthquake alert and notification system
- Portal to all earthquake and geo-hazards information

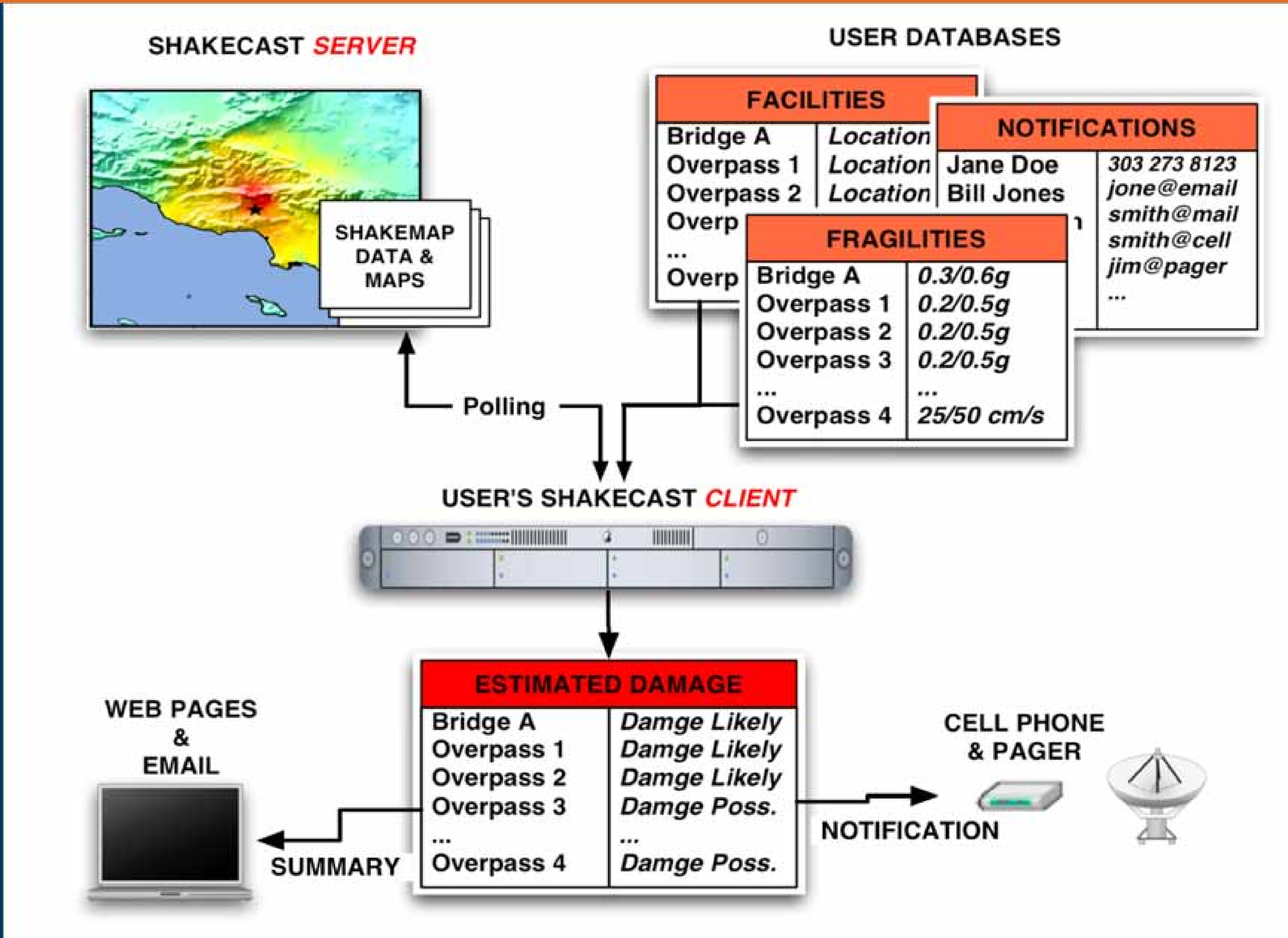


www.cisn.org

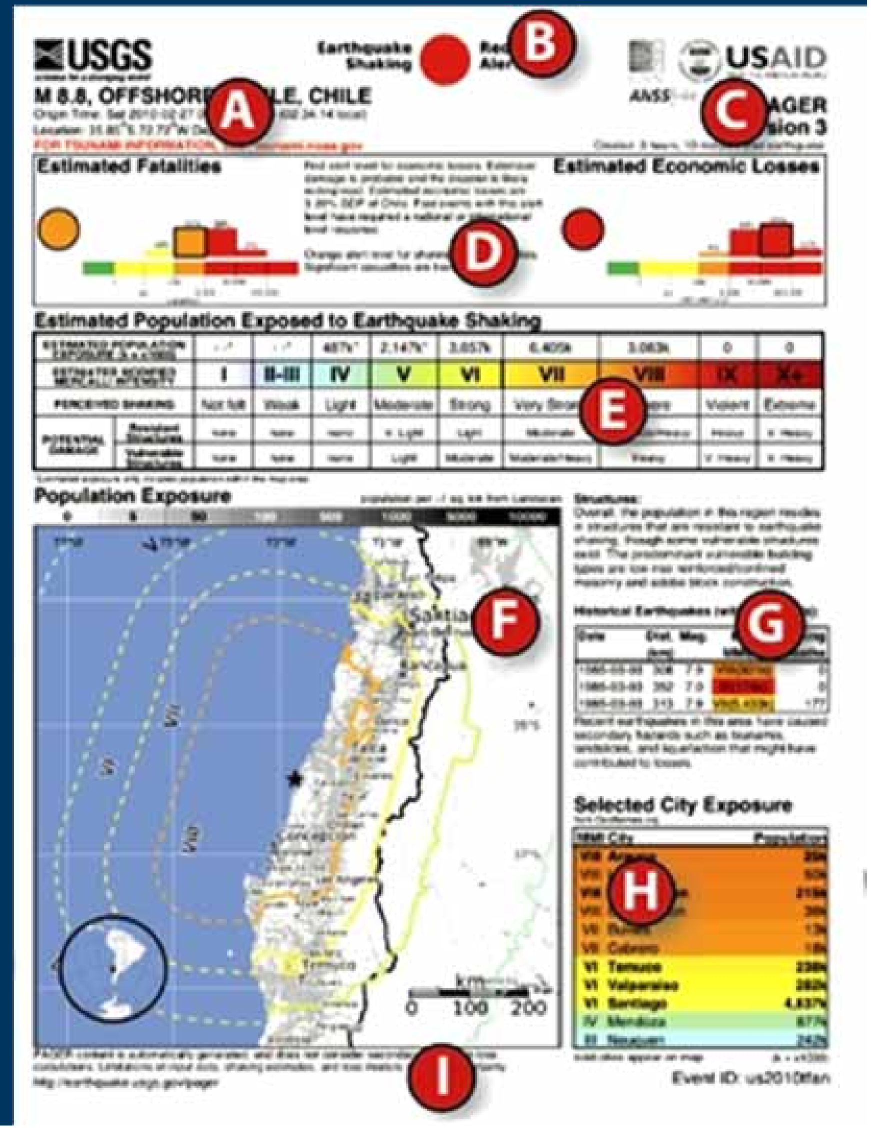
ShakeMap/Did You Feel It – Scenarios



ShakeMap/ShakeCast Flowchart



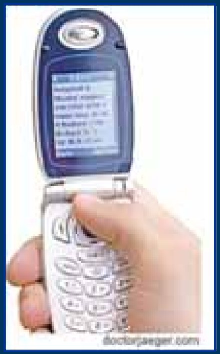
PAGER - Rapid Estimate of Earthquake Impact

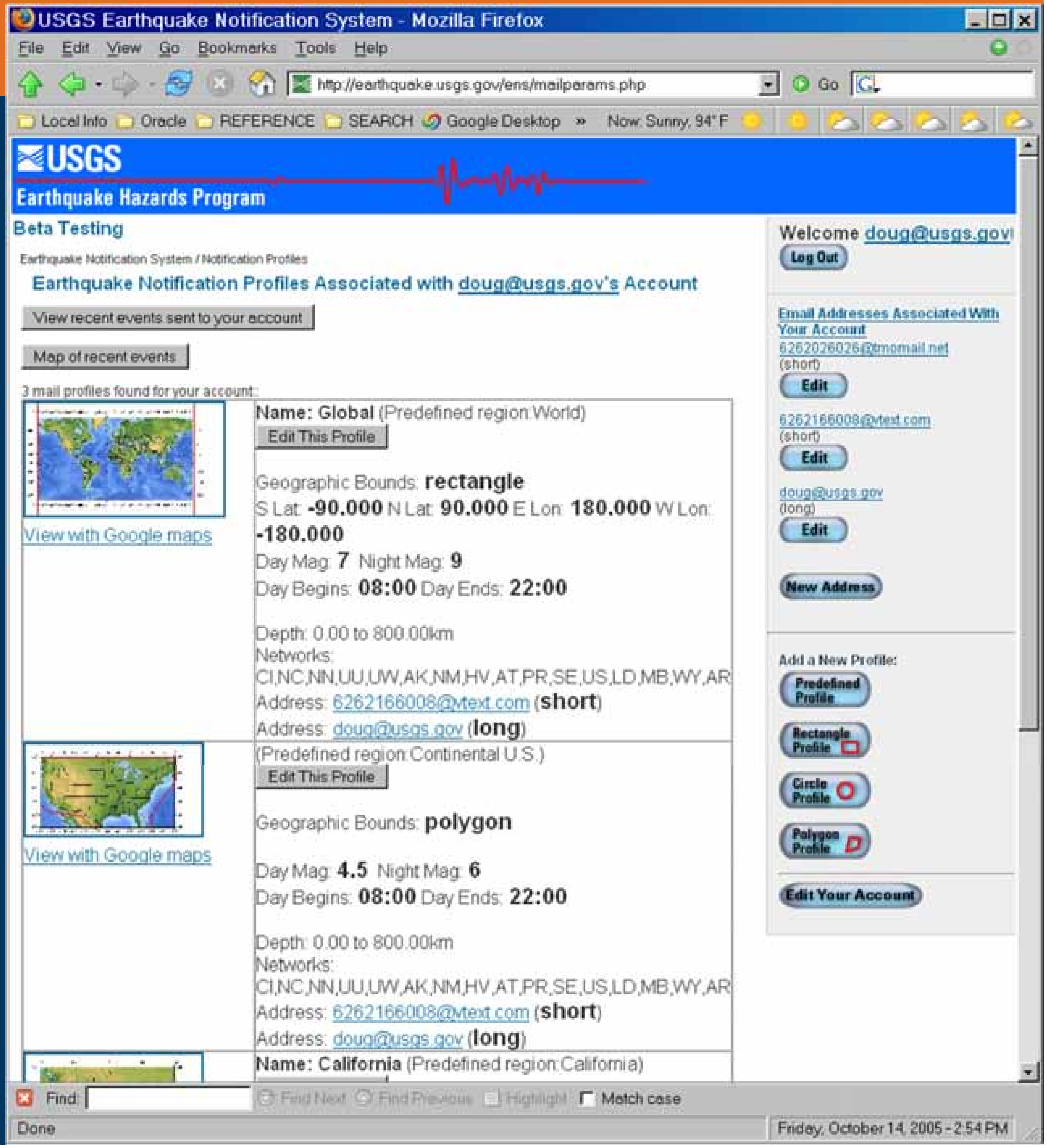


ENS:

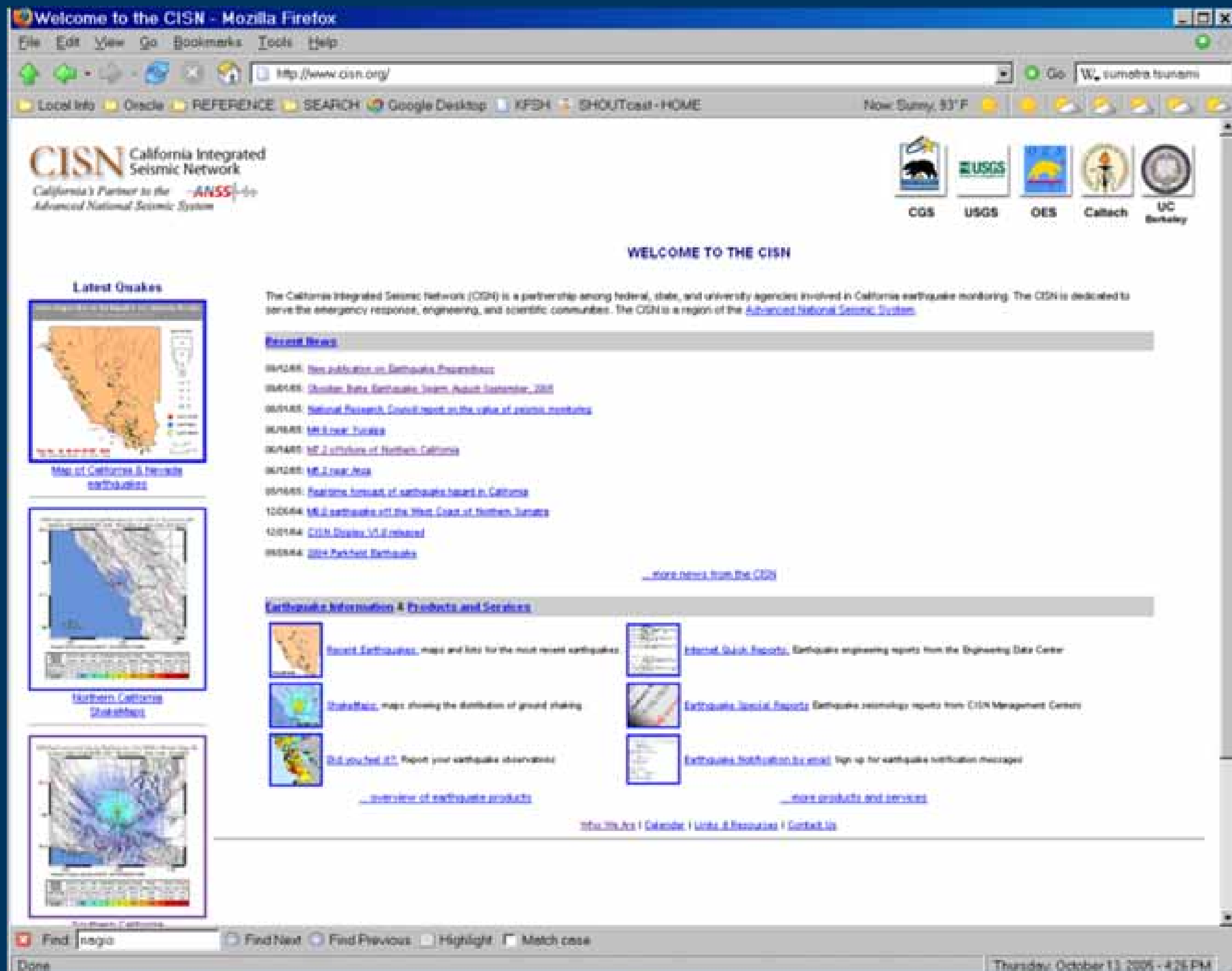
Earthquake Notification System

- User configurable E-mail & SMS messages



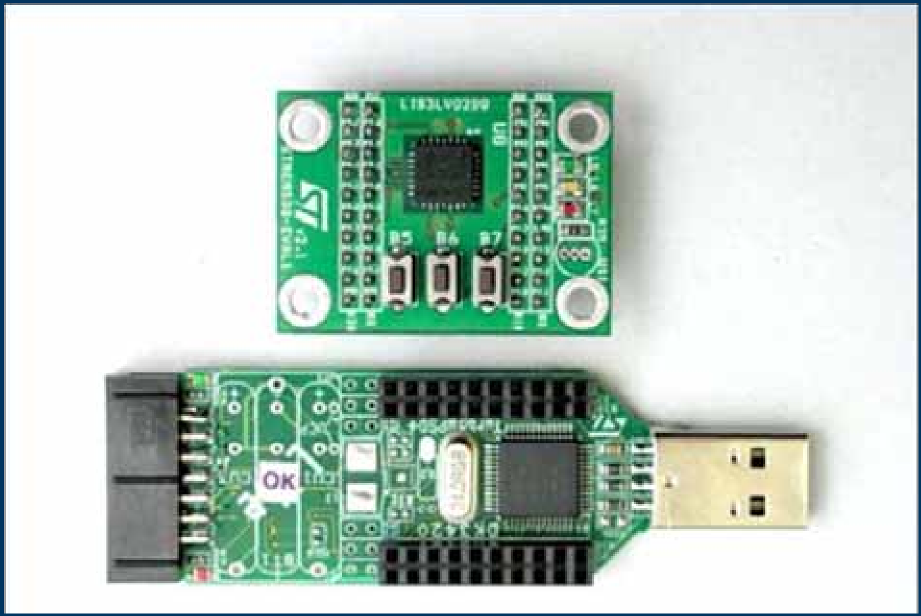


www.cisn.org


Welcome to the CISN - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://www.cisn.org/
CISN California Integrated Seismic Network
California's Partner in the Advanced National Seismic System
ANSS
CGS
USGS
OES
Caltech
UC Berkeley
WELCOME TO THE CISN
Latest Quakes
Recent News
Earthquake Information & Products and Services
Find: nagio
Find Next
Find Previous
Highlight
Match case
Done
Thursday, October 13, 2005 - 4:26 PM

Low-Cost Station

Relies on host computer for communication and calculations



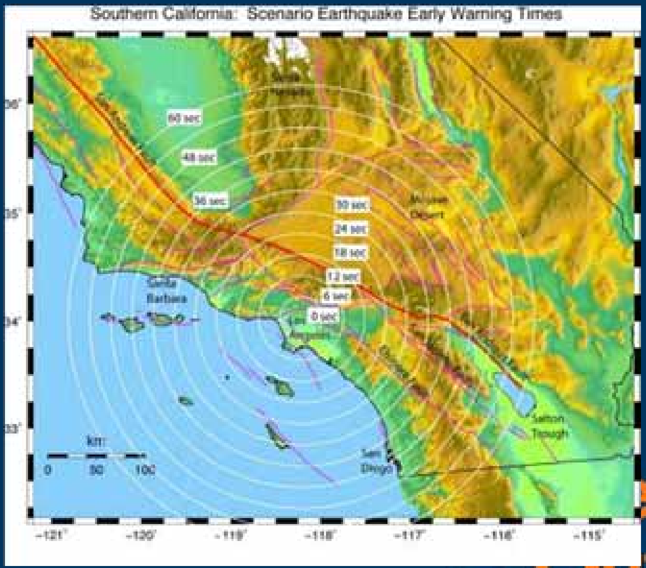
WWW. COMMUNITYSEISMICNETWORK.ORG

ShakeOut

CISN Shake /Alert

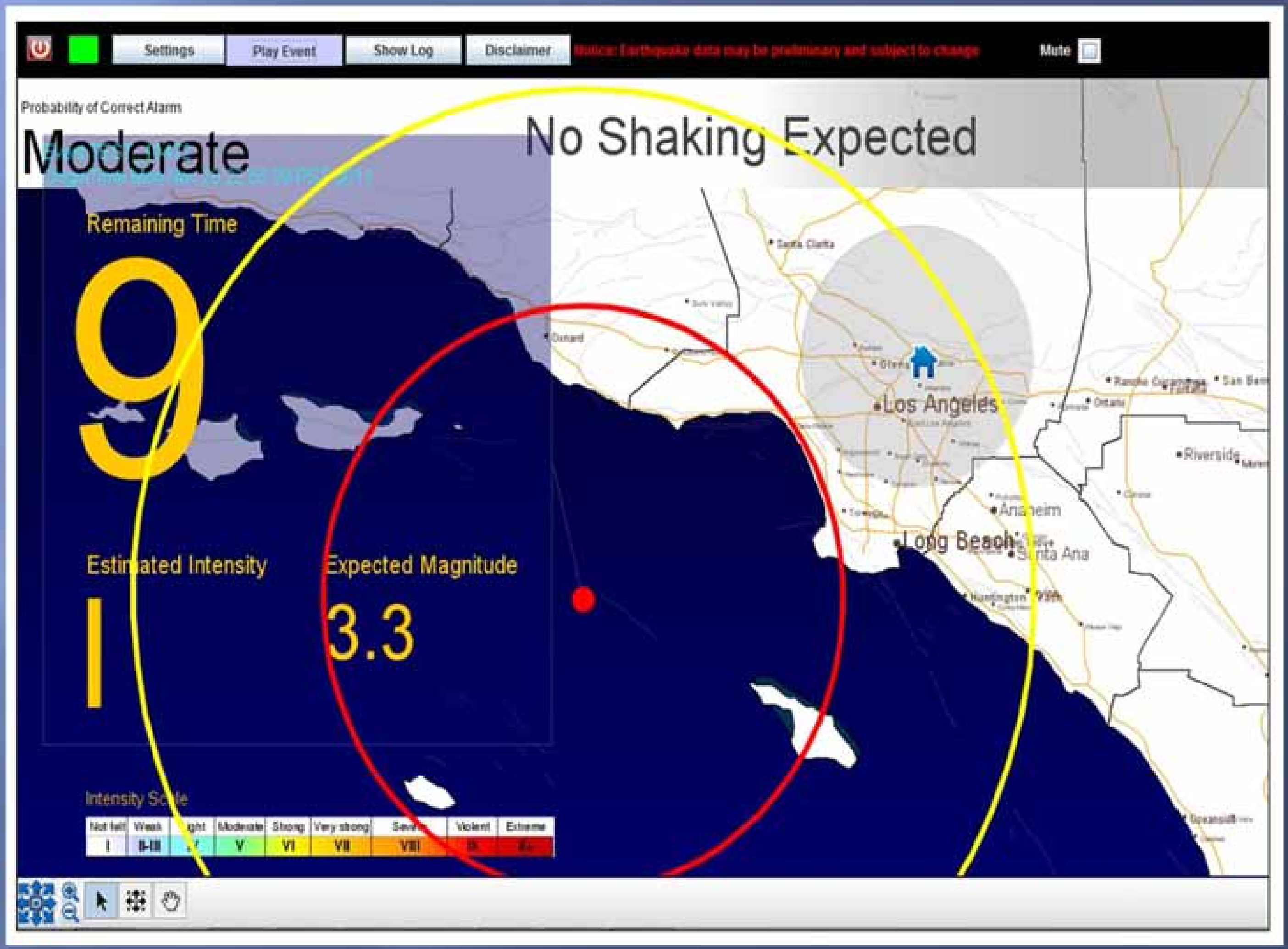
CISN California Integrated Seismic Network
California's Partner to the Advanced National Seismic System
ANSS
CGS USGS OES Caltech UC Berkeley

Earthquake Early Warning in California



Seismological Laboratory
California Institute of Technology

Earthquake Early Warning Coming to You Soon…

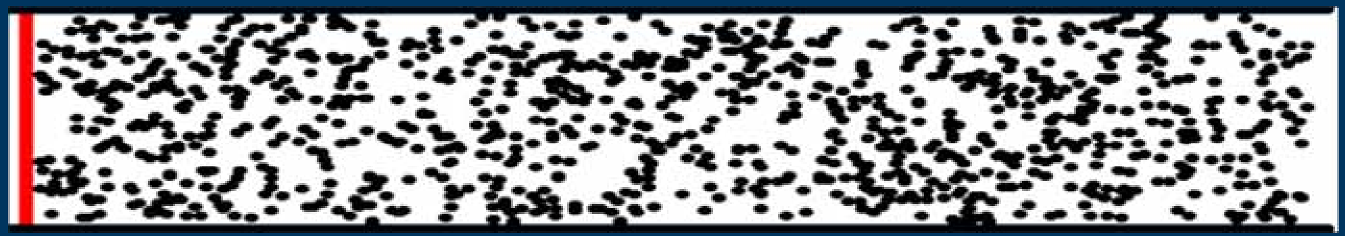


Caltech’s effort to protect your safety

Earthquake Waves

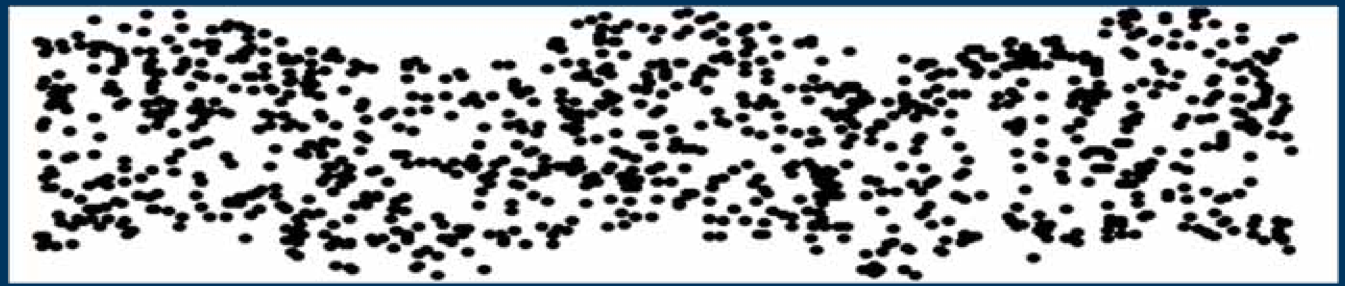
P-wave

~3.5 mi/sec



S-wave

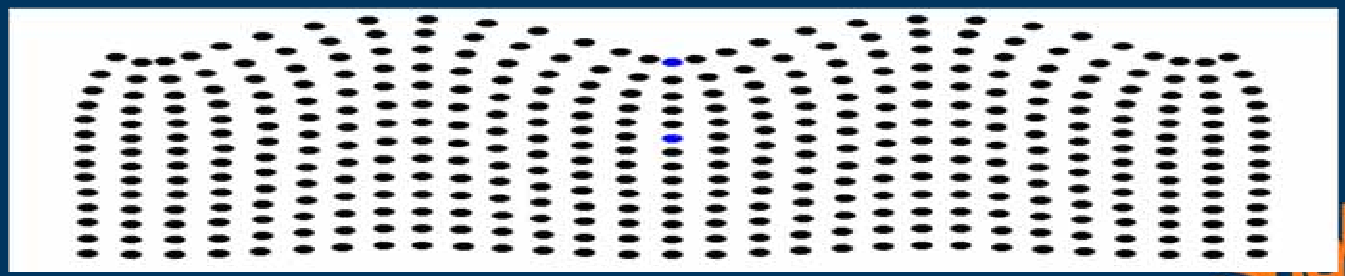
~2 mi/sec



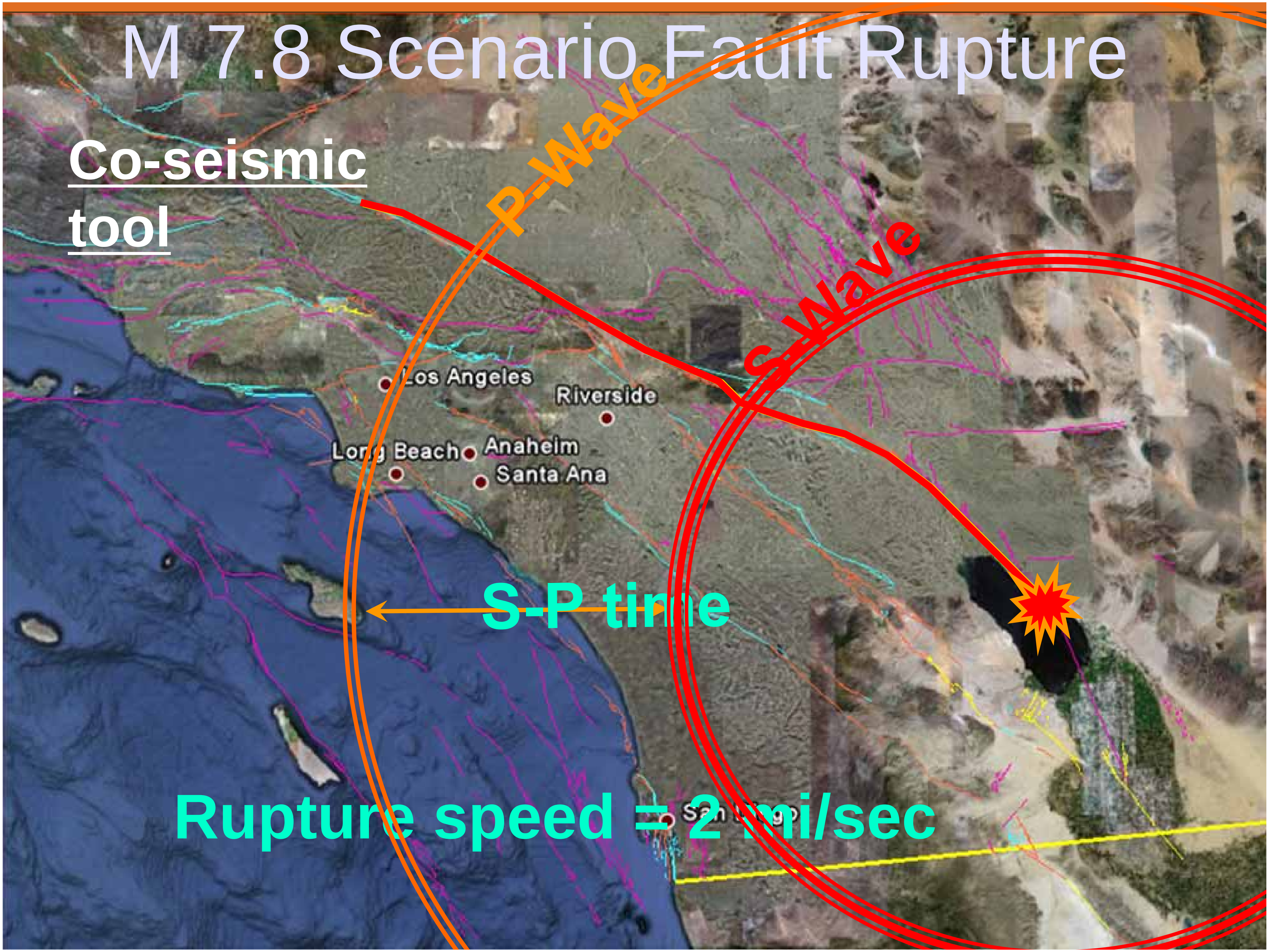
Surface wave

< 2 mi/sec

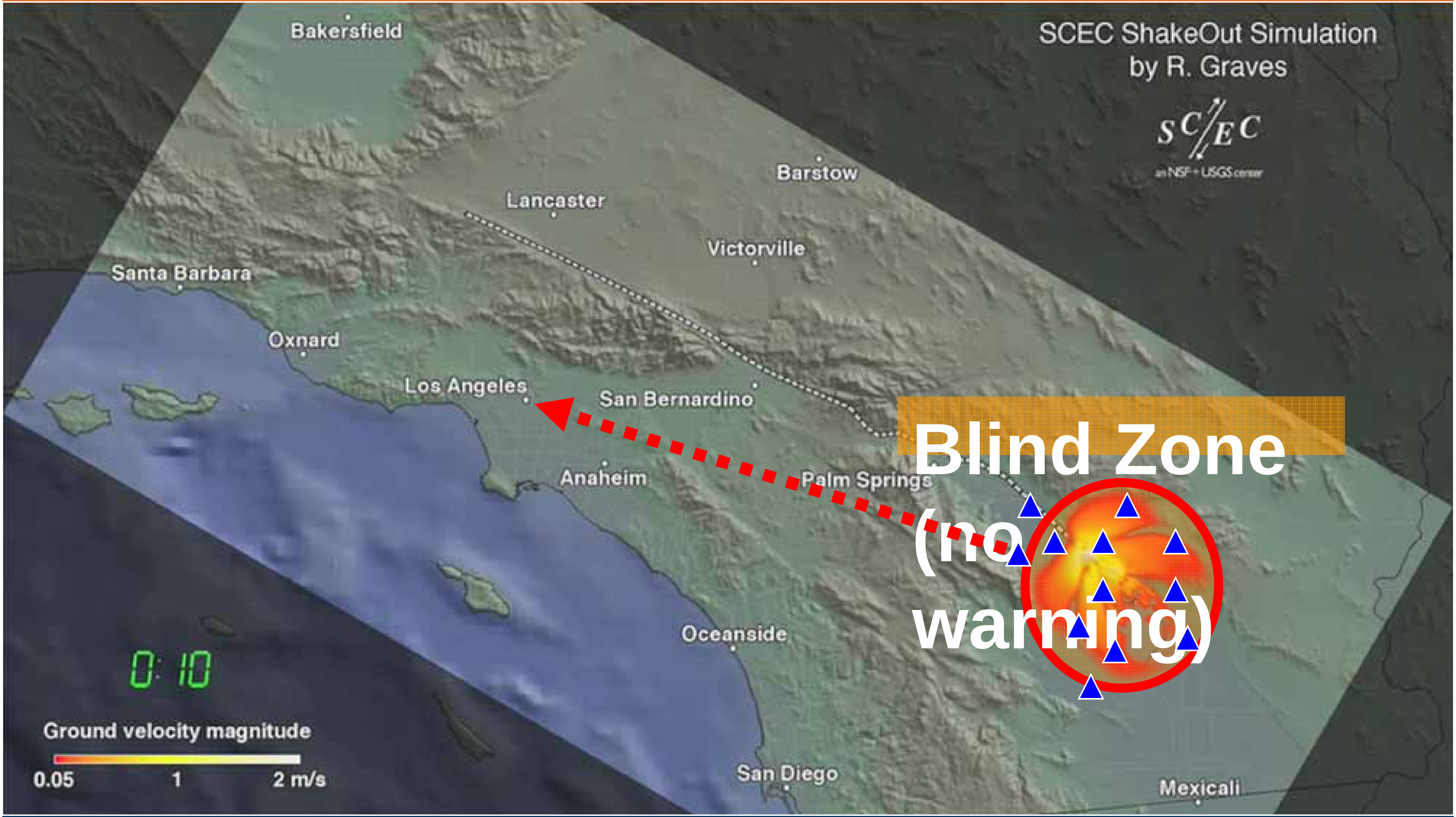
(Rayleigh)



M 7.8 Scenario Fault Rupture



Warning Issued – No warning for blind zone



System has limitations

Two Types of EEW

- On-site EEW
  - Local sensor
  - Shorter warning time
  - Detects P wave
  - Simple, low cost responses
  - More false alarms

- Network EEW
  - Sensors near source
  - Longer warning time
  - S-wave travel time
  - More complex responses
  - Targets all users
  - More reliable

CISN Shake/Alert

public alert systems

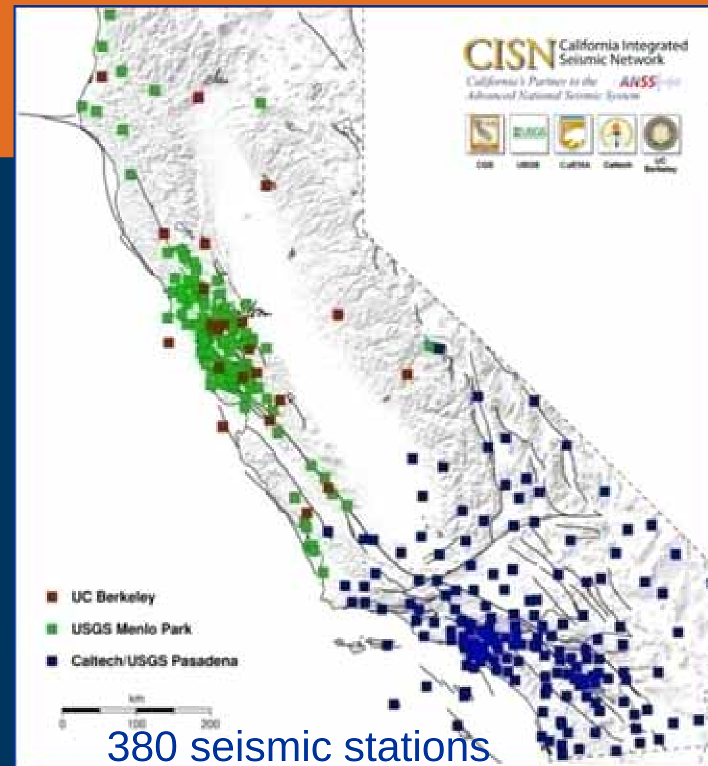
users

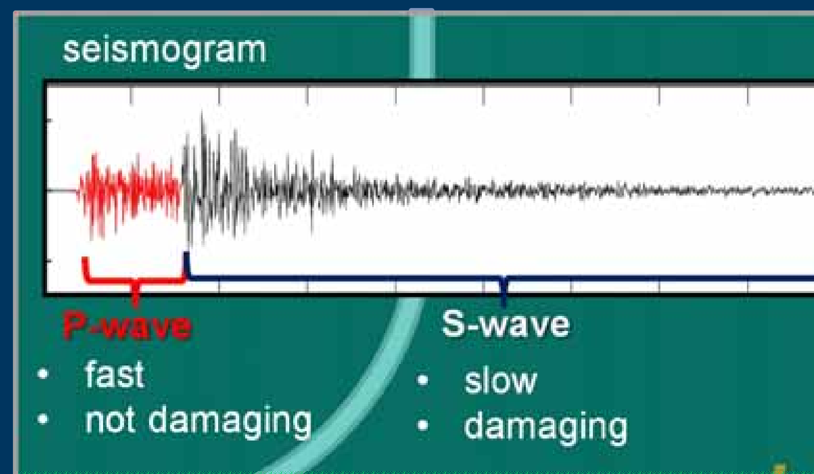
automated control systems

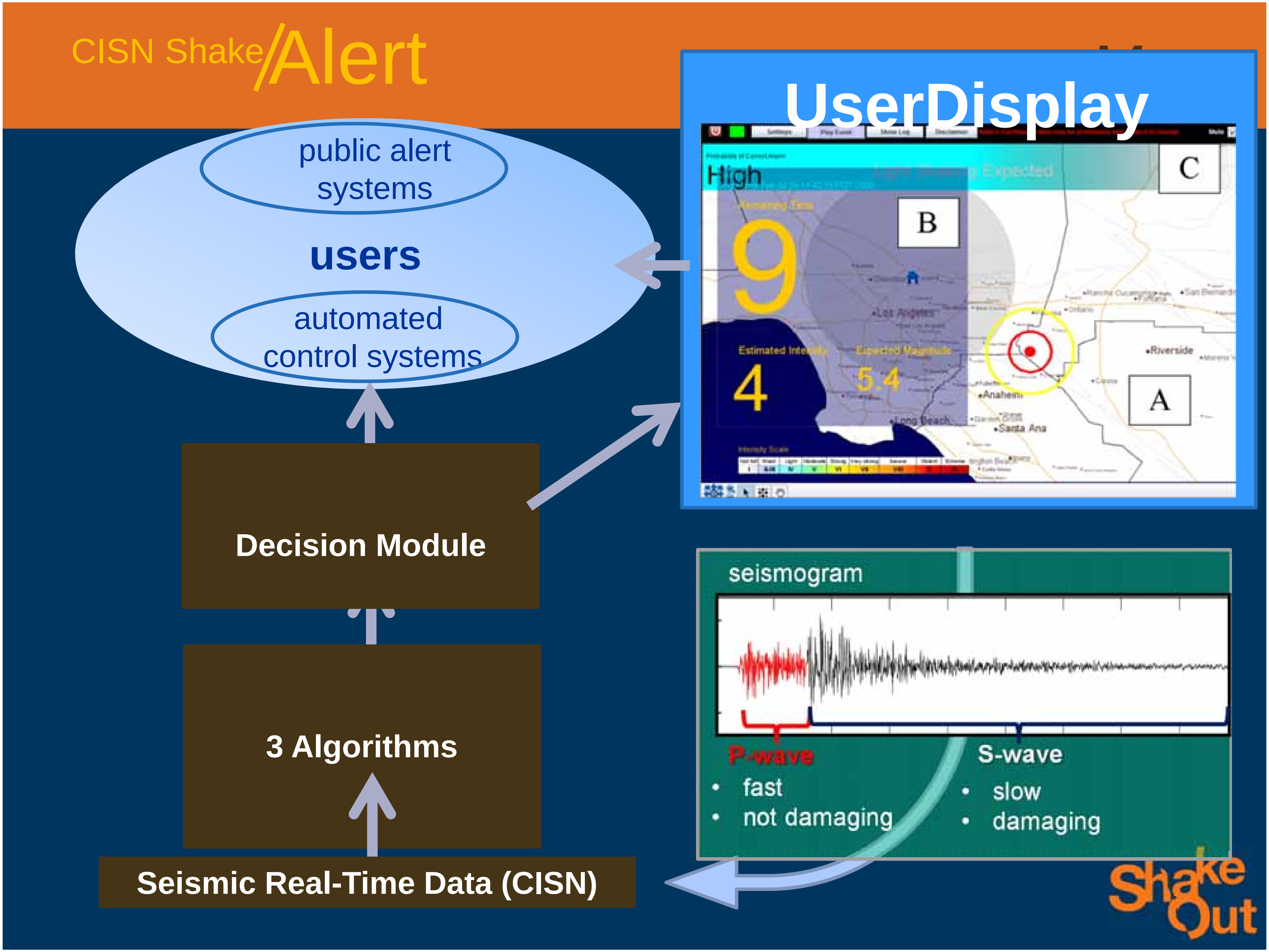
Decision Module

3 Algorithms

Seismic Real-Time Data (CISN)







CISN ShakeAlert
UserDisplay
public alert systems
users
automated control systems
Decision Module
3 Algorithms
Seismic Real-Time Data (CISN)
High
9
4
5.4
B
C
A
Los Angeles
Riverside
Anaheim
Long Beach
Santa Ana
seismogram
P-wave
fast
not damaging
S-wave
slow
damaging
ShakeOut

CISN ShakeAlert

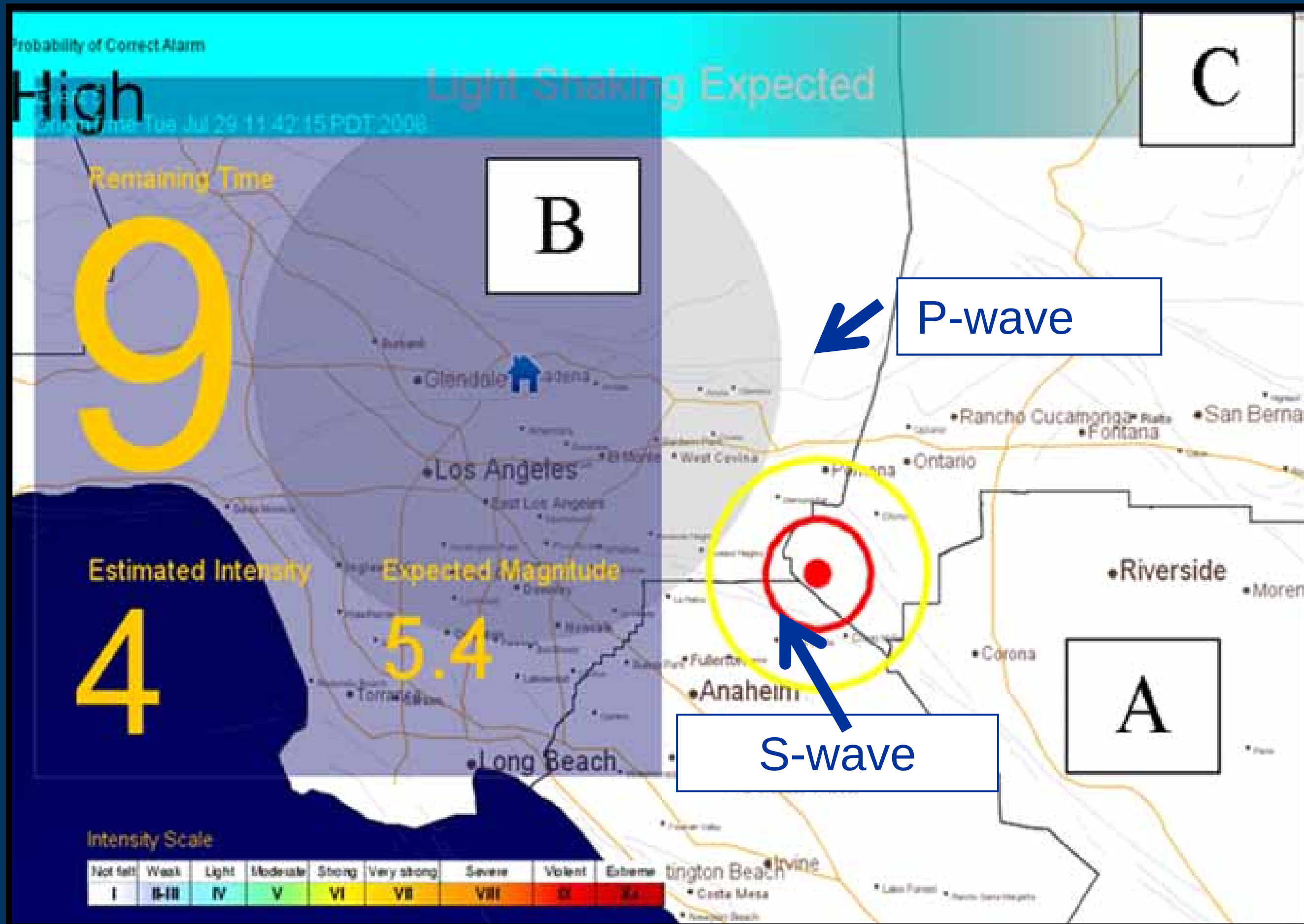
User Display

countdown

intensity

magnitude

Light Shaking Expected



LIMITATIONS

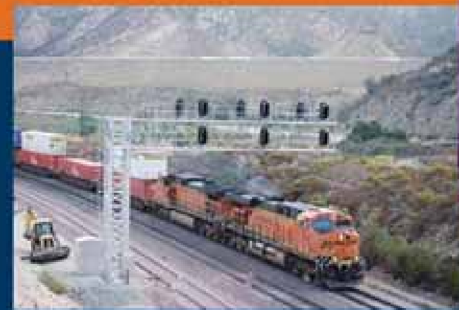
- False alarms
- Blind Zone
- Early warning challenging in California
  - Many faults and infrequent large events to test
- No receipt of data – missed alarm
- Finite faults M6.5+
  - Long rupture cannot estimate the intensity of shaking

10 -15 seconds is a long time

- Get into a safe place for protection
- Drop, Cover, Hold on
- Drivers pull over to the side of the road
- Surgeons don't operate
- People get out of elevators
- Industry can protect essential data or work
- Hazardous materials protected from causing secondary damage
- Trains slowed or stopped
- Protect goods from damage/loss

Potential Users for Early Warning?

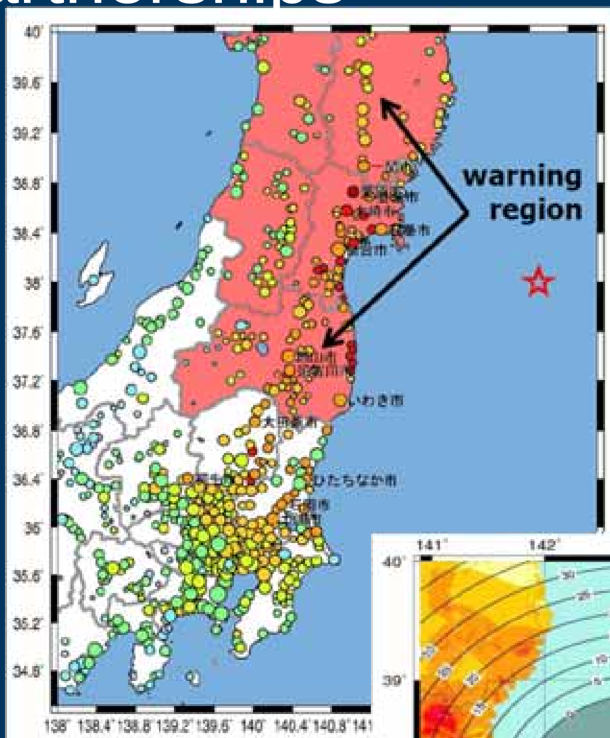
- Emergency Responders
- Transportation
- Utilities/Lifelines
- Laboratories
- Schools
- Manufacturers
- Public – get into a safe place
- Search/Rescue
- Users of Hazardous Material

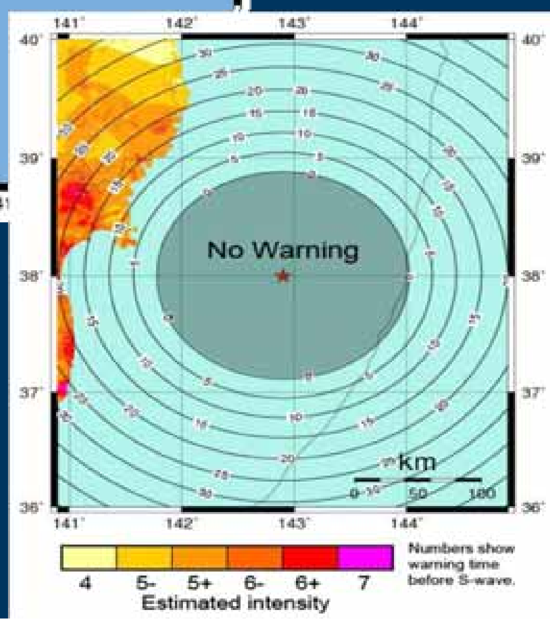






Tohoku M9.0 – EEW Alert

Automated Response Systems – Public/Private Partnerships





- **Alert was sent in 8 s**
- **Millions of people got 5 – 40 s warning**
- **24 Bullet trains were stopped with no derailments**

**Action
s taken
reduce
d**

Japan: Communicating the warning

earthquake location and hazard

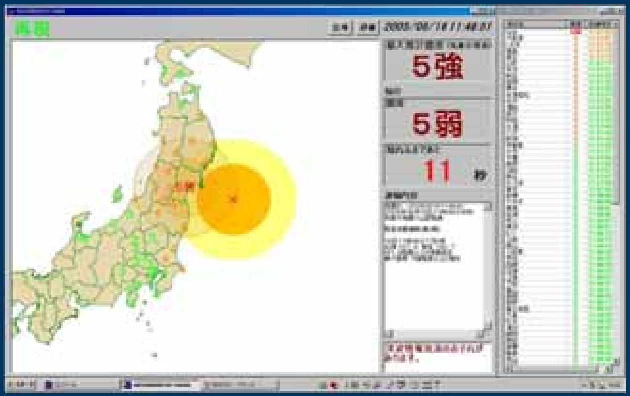
estimated shaking in your area

- TV and radio announcements
  - 124 of 127 TV stations (98%)
  - 41 AM, 35 FM radio (75%)

- J-Alert messages
  - 226 municipalities receive the warnings
  - 102 announce them with public address systems

- Cell phones
  - 3 companies (Docomo, AU, Softbank)
  - 52 million <u>can</u> receive them (47%)

- Commercial providers serve
  - power plants
  - factories
  - schools
  - hospitals
  - shopping malls

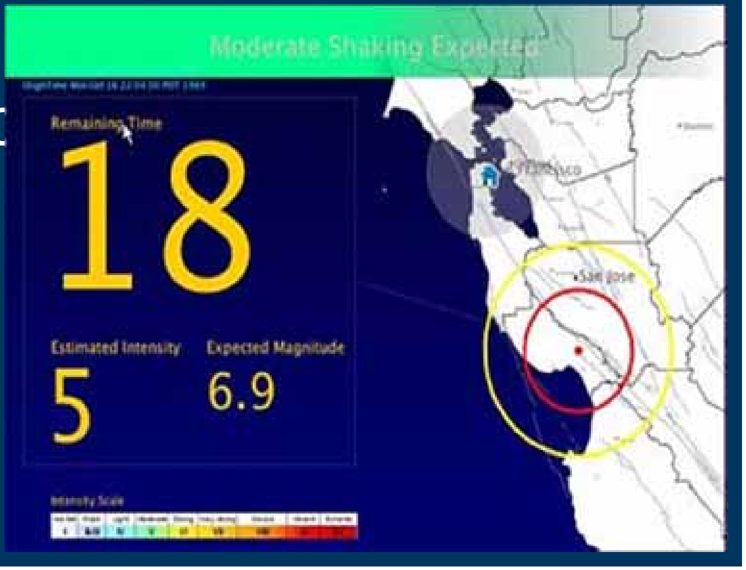


ShakeAlert Development/Testing

- Testing and feedback from potential users is essential to further development of Earthquake Early Warning

- Beta Test Users can provide valuable insights into the operations and uses of ShakeAlert that will assist in its successful development

- Feedback is a critical element in making ShakeAlert responsive to the public



Co-Seismic Tool

Identified Initial Users

*Amgen
*BART
*Los Angeles City EMD, Police, Fire
*CalEMA Warning Center
*Google.org
*Metrolink
*UC Berkeley OEP
*California Institute of Technology Safety
*SF DEM
*So Cal Edison

Disneyland
Caltrans
Los Angeles Dept. Water/Power
Los Angeles County Fire Dept. , OEM and Sheriff
Port of Los Angeles/Long Beach

* Receiving Alerts Today

15 Seconds is a long time

www.eew.caltech.edu

Southern California ShakeOut

Sign up at ShakeOut.org!

October 18, 2012

Make this a business media event!

Key Preparedness Actions

At home, work, and school:

- Consider what would happen in a big earthquake, and what you can do now to reduce damage and recover quickly.
- Practice "Drop, Cover, and Hold On" on 10/20 at 10:20 a.m.! Do a drill
- Secure Your Space
- Emergency Plan
- Out or area communication contact
- Store More Water
    - 1 gallon per person per day for at <u>least</u> 3 days and *ideally* for 2 weeks
- Have a Fire Extinguisher(s)
    - Everyone must know proper use

Thank you!

WWW.ShakeOut.org

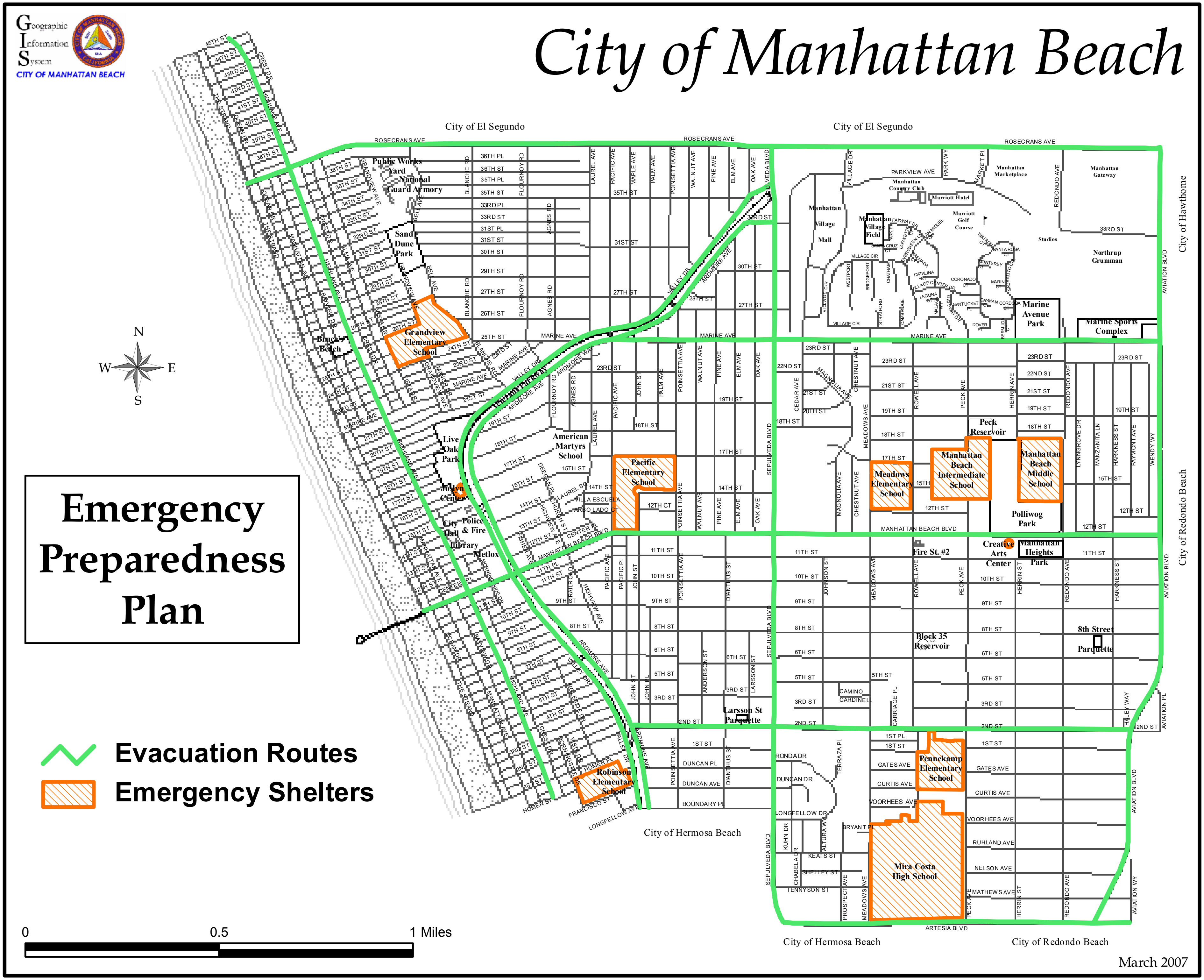
www.earthquakecountry.org

Margaret Vinci
mvinci@gps.caltech.edu
(626) 395-3298

WWW.CISN.ORG

Caltech


City of Manhattan Beach
Potential Tsunami Inundation Area
(elevation < 50' above sea level*)
5
Mean Sea Level
Potential Tsunami Inundation Area
(50 ft elevation above Mean Sea Level)
Tsunami Evacuation Zone
0
1,000
2,000 Feet
* Source: LAR-IAC contours 2006
04/04/2011
ROSECRANS AVE
THE STRAND
OCEAN DR
MANHATTAN AVE
BAYVIEW DR
HIGHLAND AVE
CREST DR
VISTA DR
ALMA AVE
GRANDVIEW AVE
BELL AVE
MANOR DR
MARINE AVE
VALLEY DR
ARDMORE AVE
MANHATTAN BEACH BLVD
HIGHVIEW AVE
INGLESIDE DR
HOMER ST
BLANCHE RD
FLOURNOY RD
AGNES RD
LAUREL AVE
PACIFIC AVE
MAPLE AVE
PALM AVE
POINSETTIA AVE
WALNUT AVE
PINE AVE
ELM AVE
OAK AVE
JOHN ST
ANDERSON ST
LARSSON ST
DIANTHUS ST
DUNCAN PL
DUNCAN AVE
12TH CT
MARINE


City of Manhattan Beach
Geographic Information System
CITY OF MANHATTAN BEACH
Emergency Preparedness Plan
Evacuation Routes
Emergency Shelters
City of El Segundo
City of El Segundo
City of Hawthorne
City of Redondo Beach
City of Hermosa Beach
City of Hermosa Beach
City of Redondo Beach
N
S
E
W
0
0.5
1 Miles
March 2007
ROSECRANS AVE
MARINE AVE
MANHATTAN BEACH BLVD
SEPULVEDA BLVD
AVIATION BLVD
ARTESIA BLVD
HIGHLAND AVE
VALLEY DR
ARDMORE AVE
Public Works Yard
National Guard Armory
Sand Dune Park
Grandview Elementary School
Bruce's Beach
Live Oak Park
Joslyn Center
City Hall
Police & Fire
Library
Metlox
American Martyrs School
Pacific Elementary School
Robinson Elementary School
Larsson St Parquette
Manhattan Village Mall
Manhattan Village Field
Manhattan Country Club
Marriott Hotel
Marriott Golf Course
Manhattan Marketplace
Manhattan Gateway
Studios
Northrup Grumman
Marine Avenue Park
Marine Sports Complex
Peck Reservoir
Meadows Elementary School
Manhattan Beach Intermediate School
Manhattan Beach Middle School
Polliwog Park
Fire St. #2
Creative Arts Center
Manhattan Heights Park
Block 35 Reservoir
8th Street Parquette
Pennekamp Elementary School
Mira Costa High School

Manhattan Beach
Proximity to Earthquake Faults