Faults in Focus: 20 Years of Earthquake Science Accomplishments

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Risk = Probable Loss (lives & dollars) = Hazard × Exposure × Fragility ÷ Resilience

Faulting, shaking, landsliding, liquefaction
Extent & density of built environment
Structural & nonstructural vulnerability
Disaster response, insurance, CAT bonds

Today's presentations will focus on hazards

Northridge catalyzed collaborations among earthquake scientists and engineers that have produced new information for reducing risk and improving resilience.
Today’s Presentations

• **Scientific accomplishments**
  – Tom Jordan (SCEC)

• **Development and application of hazard products**
  – Lucy Jones (USGS)
  – Kate Long (Cal OES)

• **Northridge 20th anniversary events and resources**
  – Mark Benthien (SCEC)
Selected Accomplishments

1. Expansion of the Southern California Seismic Network
2. Development of the Community Fault Model
3. Deployment of the Southern California Integrated GPS Network
4. Development of the Uniform California Earthquake Rupture Forecast
5. Improvement of Probabilistic Seismic Hazard Analysis
6. Development of simulation-based ground-motion prediction models
7. Scientific support of ShakeOut Preparedness Drills
1. Expansion of the Southern California Seismic Network (SCSN)
2. Development of the Community Fault Model (CFM)
Active Faults of Southern California

National Seismic Hazard Map (1996)

Northridge fault in yellow

Active Faults of Southern California
Active Faults of Southern California

National Seismic Hazard Map (1996)

Northridge fault in yellow
Other blind thrust faults in red

LA center

Active Faults of Southern California
Active Faults of Southern California

SCEC Community Fault Model (2013)

Northridge fault in yellow
Other blind thrust faults in red

LA center

Active Faults of Southern California
Active Faults of Southern California
(Northridge detail)
SCEC Community Fault Model (2013)

Active Faults of Southern California
(Northridge detail)
Active Faults of Southern California
(LA Basin detail)

National Seismic Hazard Map (1996)

Northridge fault in yellow
Other blind thrust faults in red

LA center
Active Faults of Southern California
(LA Basin detail)

Northridge fault in yellow
Other blind thrust faults in red

SCEC Community Fault Model (2013)
Active Faults of Southern California
(Ventura detail)

Northridge fault in yellow
Other blind thrust faults in red

National Seismic Hazard Map (1996)
SCEC Community Fault Model (2013)

Active Faults of Southern California
(Ventura detail)

Ventura Special Fault Study Area

Northridge fault in yellow
Other blind thrust faults in red
3. Deployment of the Southern California Integrated GPS Network (SCIGN)
Southern California Integrated GPS Network (SCIGN)
Southern California Integrated GPS Network (SCIGN)
4. Development of the Uniform California Earthquake Rupture Forecast (UCERF)
UCERF2 Data Integration

Earthquakes

Active Faults

Tectonic Motions

Southern California Earthquake Center
Working Group on California Earthquake Probabilities (Field et al., 2007)

Uniform California Earthquake Rupture Forecast (UCERF2)

CALIFORNIA FAULTS
Probability of M≥6.7 Earthquakes:
1. S. San Andreas 59%
2. Hayward-Rodgers Creek 31%
3. San Jacinto 31%
4. N. San Andreas 21%
5. Elsinore 11%
6. Calaveras 7%
7. Garlock 6%

Ratio of time-dependent to time-independent participation probabilities for M ≥ 6.7
Working Group on California Earthquake Probabilities (Field et al., 2013)

Uniform California Earthquake Rupture Forecast (UCERF3)
5. Improvement of Probabilistic Seismic Hazard Analysis (PSHA)
National Seismic Hazard Map (1990)
6. Development of simulation-based ground-motion prediction models (CyberShake)
NGA (2008) Attenuation Relations used in National Seismic Hazard Maps

LA Region Models
Spectral Acceleration at 3 s

near-fault effects

basin effects

NGA
Campbell & Bozorgnia

NGA
Chiou & Youngs

NGA
Abrahamson & Silva

PE = 2%/50 yr
UCERF2, no background seismicity
LA Region Models
Spectral Acceleration at 3 s
CyberShake (2008)
Simulation-Based Hazard Model

NGA
Boore & Atkinson

NGA
Campbell & Bozorgnia

NGA
Abrahamson & Silva

PE = 2%/50 yr
UCERF2, no background seismicity
SCEC Community Velocity Models (CVMs)

Data sources
Surface geology
Well logs
Refraction surveys
Reflection surveys
Seismic tomography
Geologic models
7. Scientific support of the ShakeOut Earthquake Preparedness Drills
Great Southern California ShakeOut
November 13, 2008

Scenario Results

- M7.8 mainshock
- Large aftershocks
  - M7.2, M7.0, M6.0, M5.7…
- 10,000-100,000 landslides
- 1,600 fire ignitions
  - 300,000 buildings significantly damaged
  - Widespread infrastructure damage
  - $213 billion direct economic losses
  - 270,000 displaced persons
  - 50,000 injuries
  - 1,800 deaths
  - Long recovery time

Exercise Results

- Largest emergency response exercise in US history
- Golden Guardian exercise
- Public events involving 5.3 million registered participants
- Demonstrated that existing disaster plans are inadequate for an event of this scale
- Has motivated reformulation of emergency response

ShakeOut “ShakeMap”
ShakeOut Preparedness Exercises

The ShakeOut inspires discussion (about earthquakes) and taking action as individuals, organizations & communities

Millions of other people see & discuss:

ShakeOut exercises have been adopted across the nation and around the world…
2013 ShakeOut Earthquake Drills

Total Registration (worldwide)
- 2013: 24.7 million
- 2012: 19.5 million
- 2011: 12.5 million
- 2010: 8.0 million
- 2009: 6.9 million
- 2008: 5.4 million

New regions in 2013:
- American Samoa
- DE & WV added to SouthEast
- Hawaii
- NorthEast (PA, NJ, NY, CT, RI, MA, VT, NH, ME)
- CNMI & USVI
- Charlevoix (Quebec)
- Expansion across Japan
End