

**A Conditionally Active Category  
for Faults within and adjacent to  
Communities in the Basin and  
Range Province**

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# Reduce the Cost of Earthquakes to Society

- Some communities are extremely vulnerable to the costs of a damaging earthquake,
- We need to do a better job of capturing *unanticipated* events,
- Too many potentially hazardous faults are unacknowledged in our communities.

# Basin and Range Province Setting

- Overall wealth and assets are not large
- Large financial disasters can be fatal to a community
- Many rural communities are small or are still growing, so there is an opportunity to build them safer and more earthquake-resistant

# Christchurch from Port Hills Feb 22, 2012

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From Ian Buckle, UNR Eq. Engineering

# Collapse of concrete structures (Pyne Gould Guinness Building)



**Magnitude 6.3**  
**183 casualties**  
**1400 commercial buildings demolished**  
**10,000 homes demolished**  
**\$20B; 3x assets Christchurch (pop. 400k);**  
**11.7% NZ 2009 GDP**

From Ian Buckle, UNR Eq. Engineering

# 2008 Wells, Nevada Earthquake



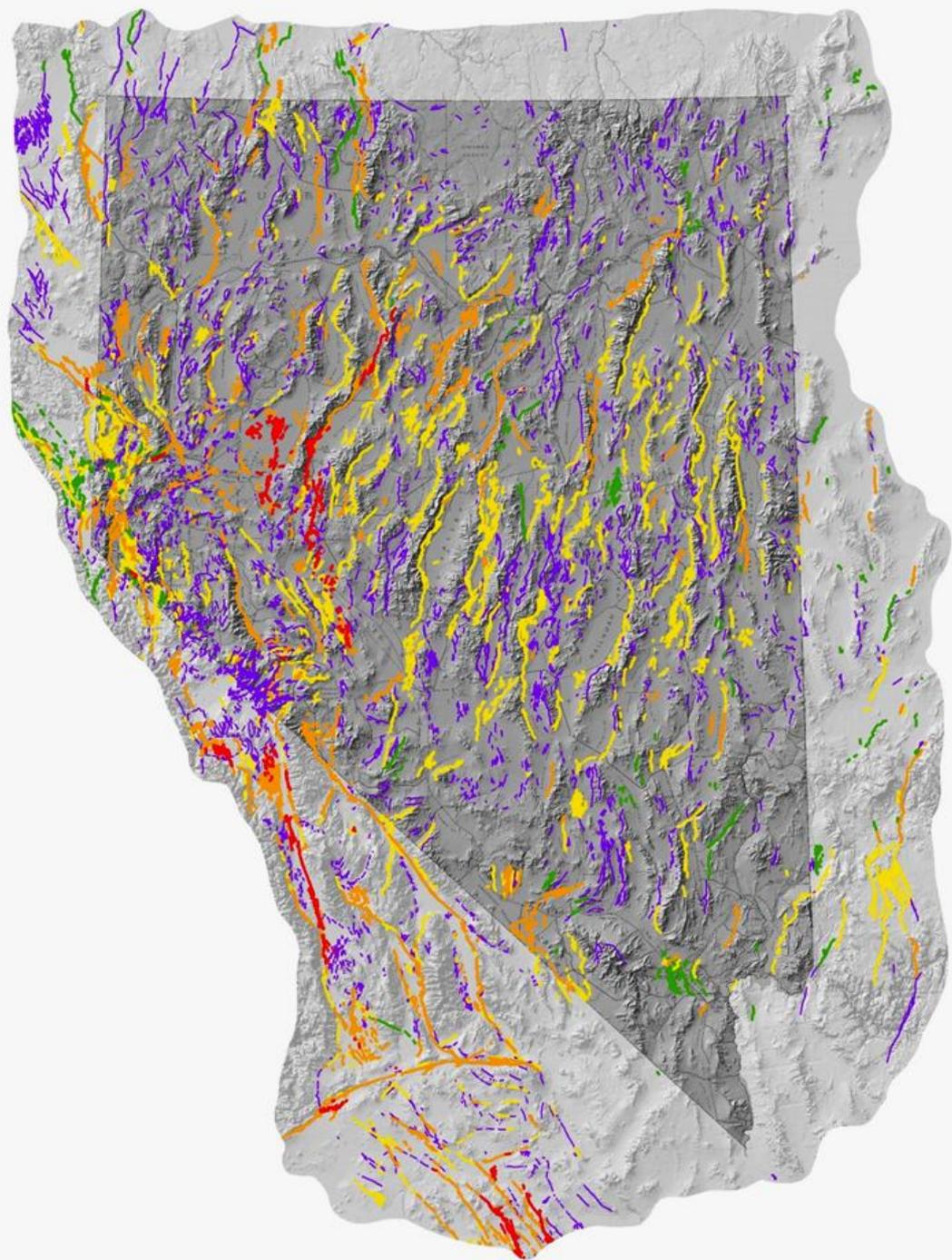
## **Reduce the cost of earthquakes -**

involves engineering geologists,  
engineers, geotechnical engineers,  
seismologists, and so on,

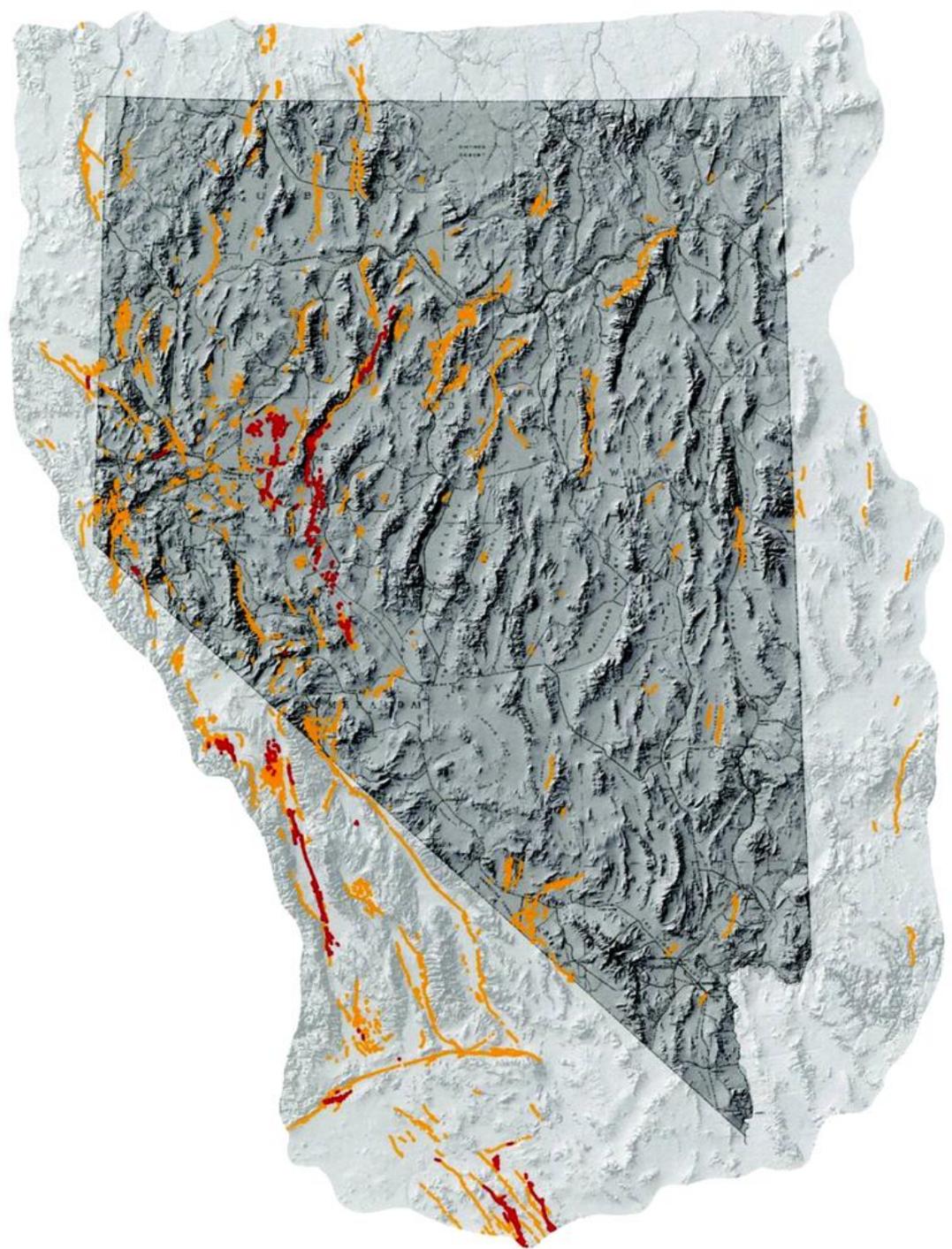
**The comprehensive identification  
of earthquake sources in  
communities is a critical step for  
seismic hazard characterization.**

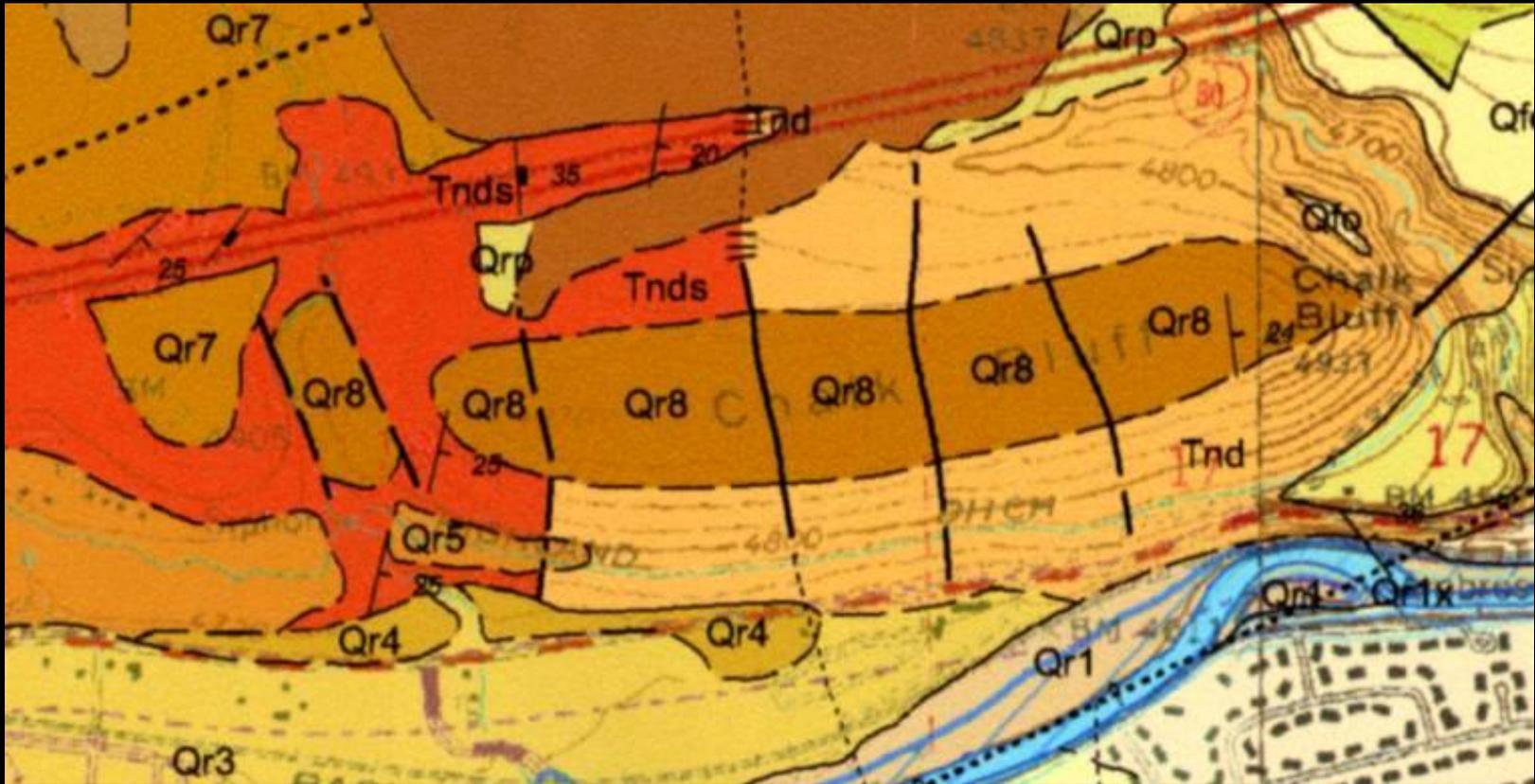
- A fundamental problem is that most faults in the Basin and Range Province are poorly studied and understood.
- Few programs in BRP to systematically study faults and identify hazardous faults, like the Alquist-Priolo Act. Engineering geologists and other professionals make the call fault by fault.
- Most fault activity criteria are *artificial*.

**All  
Quaternary  
Faults**



**Faults with  
Activity  
<15,000 yrs**





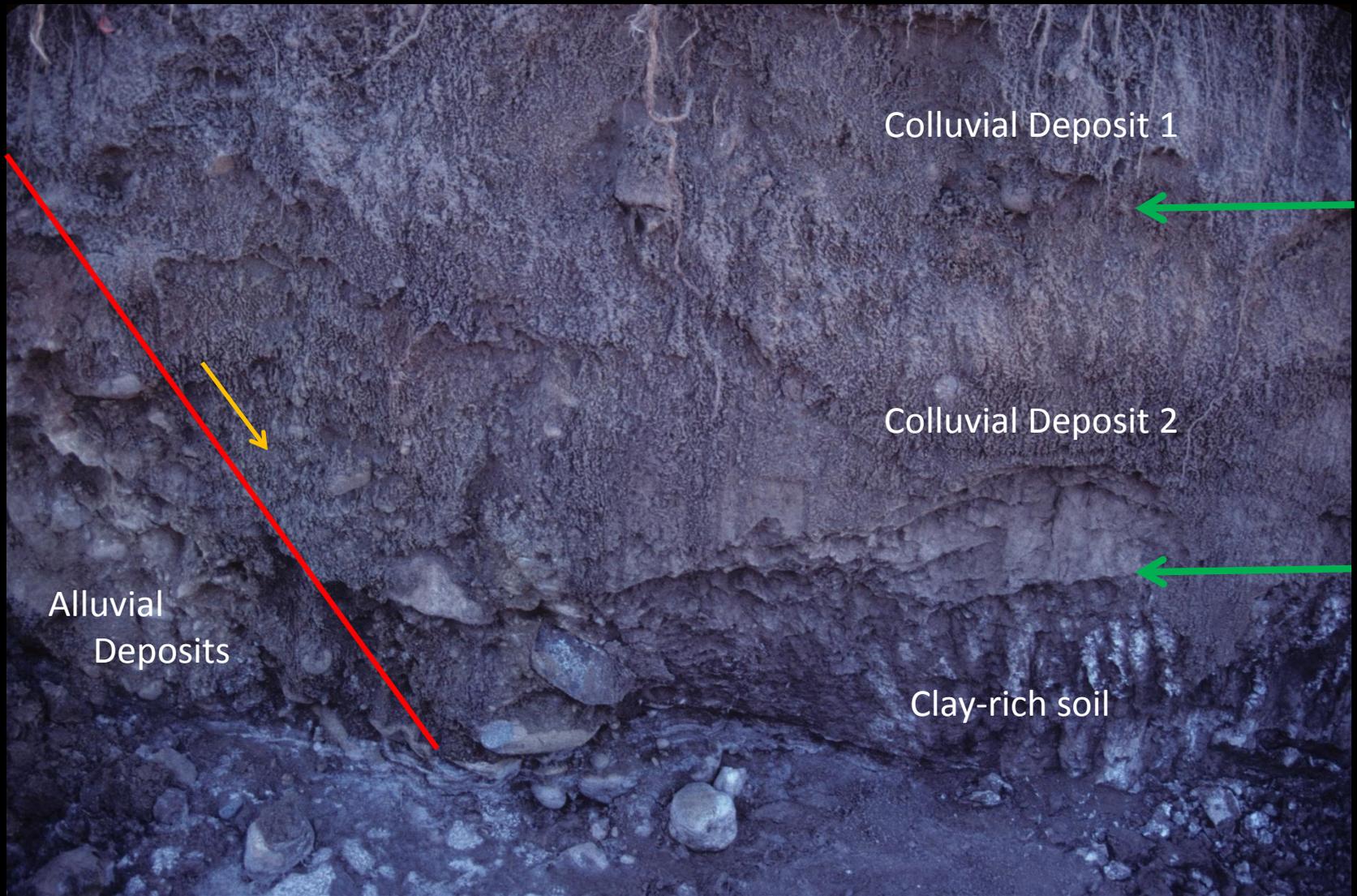
Qr8 - >180 ky age (Bell and Garside, 1987;  
Bell and Pease, 1980)

**Ramelli and others (2012)**

## Faults in Chalk Bluffs, western Reno, Nevada



**Fault scarps in Chalk Bluffs**



Trench exposed older soil down-dropped by two or three events. (~8' exposure)

# First usage of the term **Conditionally Active fault**

- **California Division Safety of Dams, 2001:**  
William A. Fraser, Chief, Geology Branch
- First suggested by Clarence Allen, who was a member of the Division's Advisory Board
- **"A conditionally active fault is defined as having ruptured in Quaternary, but its displacement history during the last 35,000 years is unknown."**

# Problem Safety of Dams Was Trying to Solve

Some unstudied faults that were not labeled as Holocene were actually hazardous faults to dams, but were being discovered after the dams were built.

How do we highlight faults within BRP  
*communities* that are inadequately  
studied but are potential earthquake  
hazards?

How do we highlight faults within BRP communities that are inadequately studied but are potential earthquake hazards?

**Conditionally Active Fault Category**

# Conditionally Active Fault

- Meets criteria of fault activity that warrants further study.
- Forces a closer, more careful inspection of faults within and adjacent to communities (capture more unanticipated events).

# A Few Ideas on Criteria

- Indications of potential activity – such as fault scarps, seismic activity along a fault
- Longer time frames of time-since-last-rupture – poss. 500 ky in BRP within communities
- McCalpin (2011) – faults that are near the end of their seismic cycle can be hazardous

# Indicators of Fault Activity

- Single-event fault scarps in alluvium
- Compound fault scarps in older alluvium
- Basal fault facets  $> 30$ ish feet high (or less?)
- Faults that have a slip rate of  $\geq 0.05$  m/ky
- Fault offset of deposits  $\leq 500$  ky
- Seismic activity along a fault
- Deformation from geodesy along a fault

# McCalpin (2011)

Points out that recent disastrous earthquakes have occurred along low-to-moderate slip-rate faults that were *near the end of their seismic cycle*.

# McCalpin's list

- **2001 Bhuj, India Eq. (20,023 casualties)**
- **2003 Bam, Iran Eq. (31,000 casualties)**
- **2005 Kashmir, Pakistan Eq. (80,361 casualties)**
- **2008 Sichuan Province, China Eq. (70,000 casualties)**
- **2010 Port-au-Prince, Haiti Eq. (316,000 casualties)**

# Dealing with Conditionally Active Faults

- Avoid or investigate faults
- Use age criterion, such as activity within the last 130 ky
- If a fault is found to be near the end of its seismic cycle (e.g., ARI=200ky; last event @ 275ky), it should be considered a hazardous fault
- Guilty until proven innocent (community decision)

# Appeal and Strategy

- We should not use artificial hazardous fault criteria that are too incomplete for communities in the Basin and Range Province,
- We should develop a strategy for identifying and handling **conditionally active faults**, agree as a profession that this is wise, and encourage local community governments to adopt such criteria.

# Conclusions

The **conditionally active fault criteria** is an important, potential tool to account for hazardous faults in BRP communities, which will reduce the number of unanticipated earthquakes.



# Conclusions

- The **conditionally active fault criteria** is a really awesome tool to help recognize hazardous faults for the greater good of society.
- **Conditionally active fault criteria = GOOD**

# The appeal to the Engineering Geologists

- We need to reduce the cost of earthquakes on society,
- The BRP has fragile, expanding communities that are expanding and can be wisely guided to minimize earthquake damage,
- Engineers can design buildings to be earthquake resistant if they are given the correct input parameters.

- A more comprehensive assessment of earthquake hazards will lead to a reduction of the occurrence of unanticipated earthquakes.
- The next earthquakes that are going to occur are the most important events to prepare and design for.