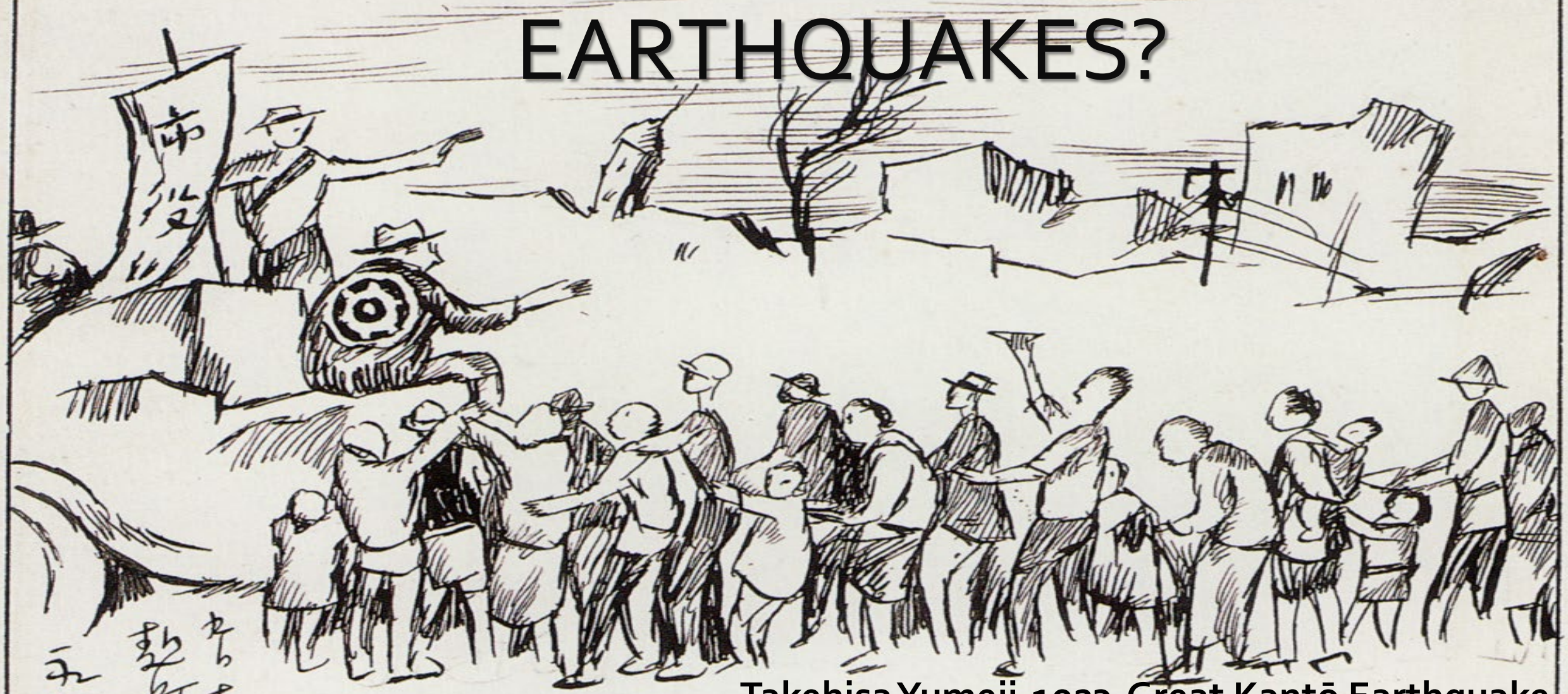
Does Arizona need to prepare for EARTHQUAKES?



Takehisa Yumeji-1923-Great Kantō Earthquake

Arizona has earthquakes!

As do neighboring states and northern Mexico. Destructive ground shaking from earthquakes does not respect state or national boundaries.

Index

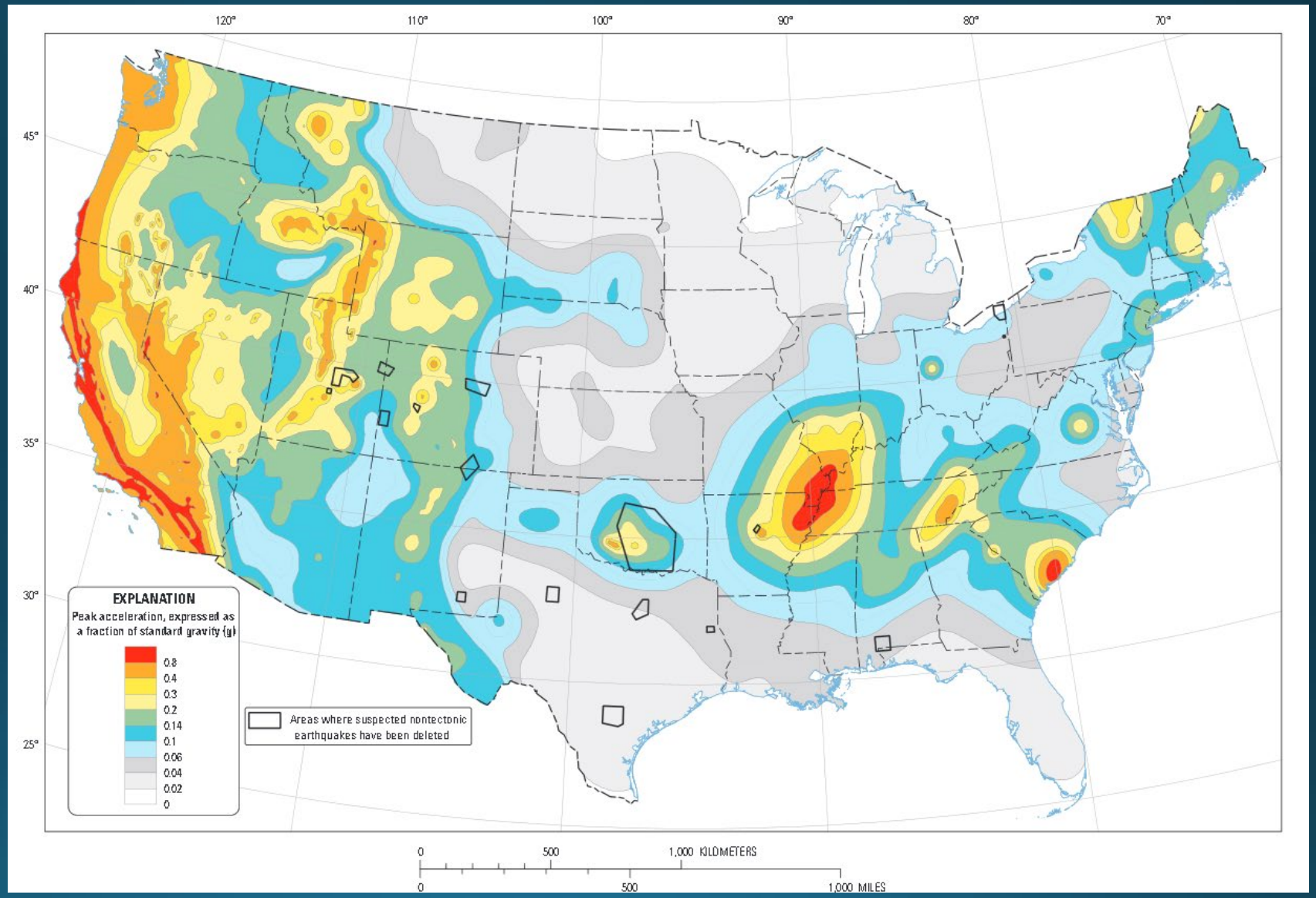
UA Science

Dr. Michael Conway
Senior Res. Scientist
Arizona Geological Survey

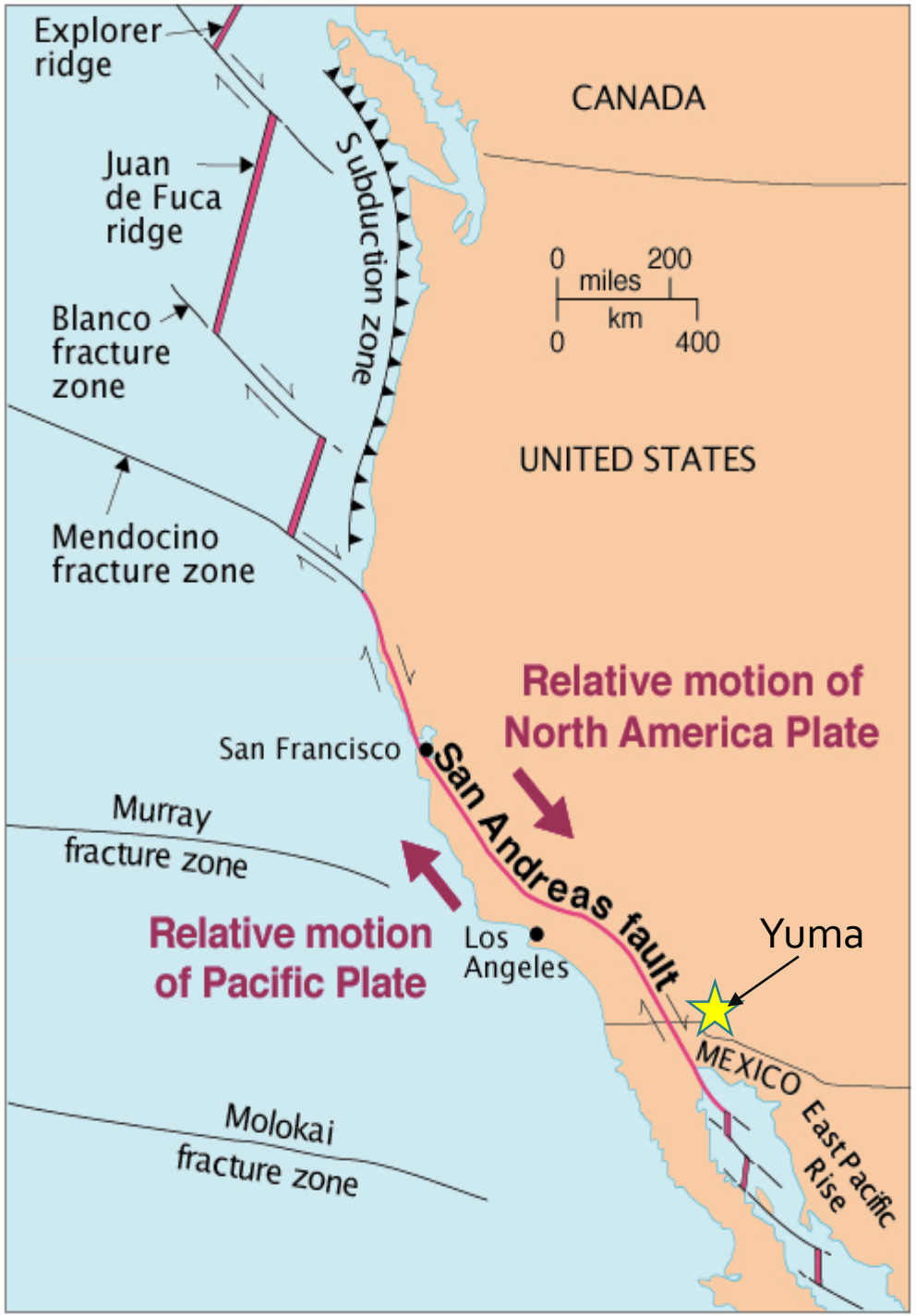
In a word; yes!

Arizona is ‘earthquake country’, with about 100 earthquakes occurring within the state each year.

And earthquakes originating in nearby California, Nevada, Utah, New Mexico and Mexico can impact Arizona infrastructure and residents as well.



Earthquake hazard map of contiguous U.S. by U.S. Geological Survey



Why earthquakes? I.

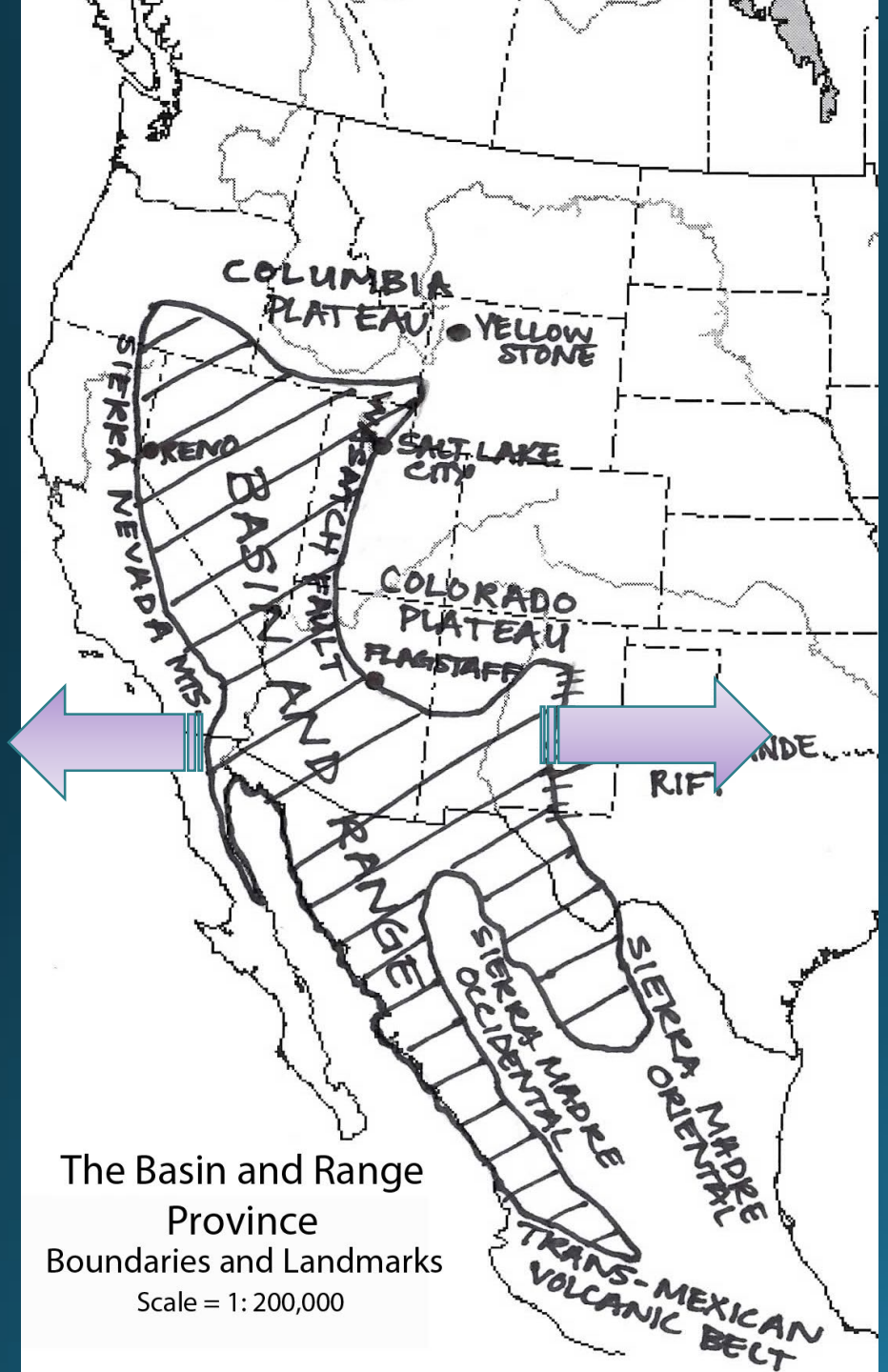
Arizona is situated on the western edge of North America, adjacent to the North America and Pacific tectonic plate boundary. The San Andreas Fault system has been active for more than 25 million years and is capable of producing destructive M6-M8 earthquakes.

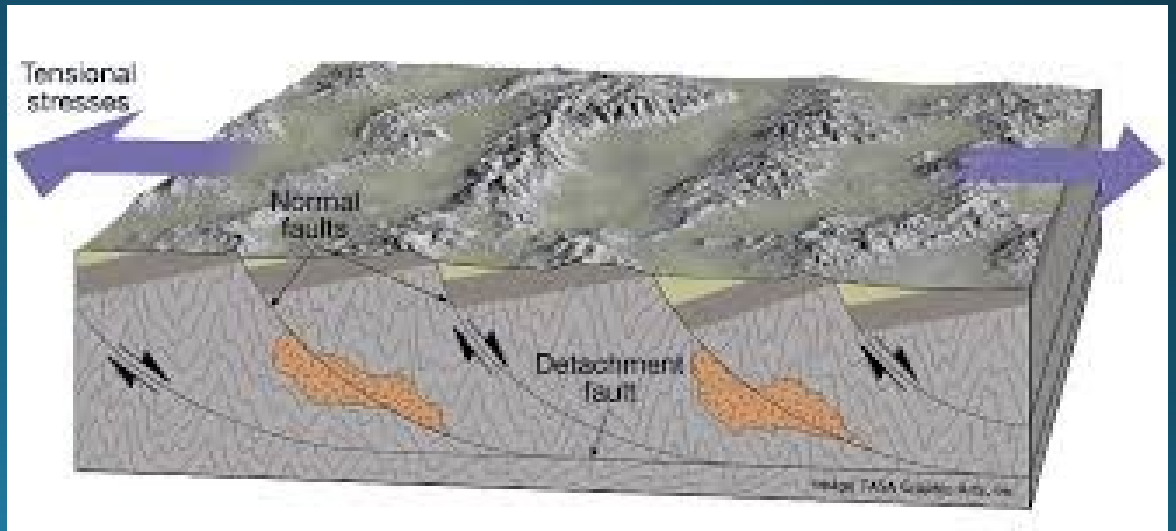
California registers more than 1,000 earthquakes each month. Yuma, Arizona is 50 miles east of the Imperial Fault, a segment of the San Andreas fault system. An earthquake on the Imperial Fault will, and has, rock(ed) Yuma.

Why earthquakes? II.

Western and southern Arizona reside in the extensional Basin and Range Province (B&R).

Over the past 20+ million years extension in the B&R has produced 100s of range front faults. Episodic movement along those faults produce small-, to moderate-, to rare large-magnitude earthquakes.

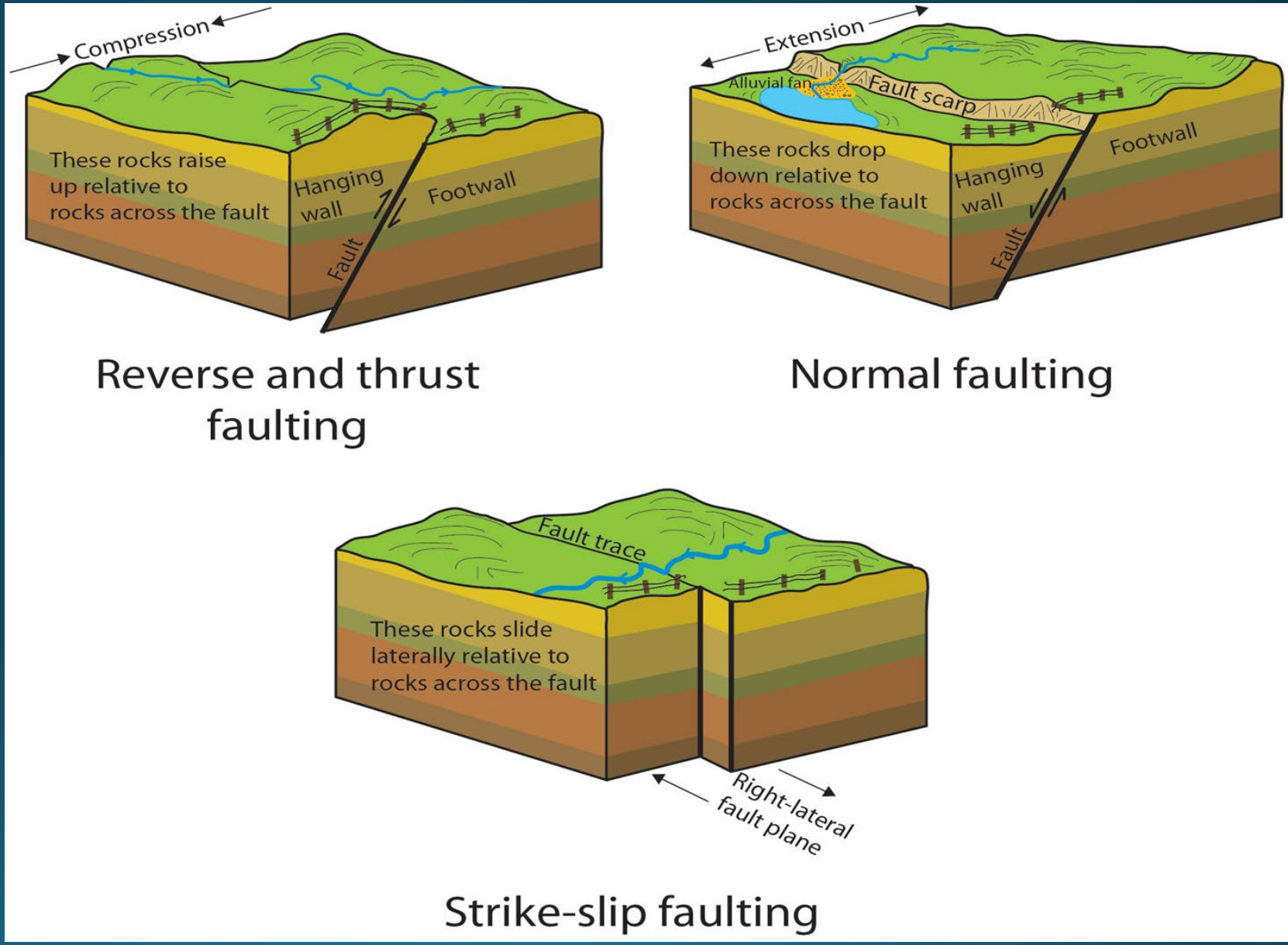




Faults & Earthquakes I

<u>3 principal types of faults</u>

- Reverse & thrust from compression
- Normal from extension (e.g., Basin and Range Faults)
- Strike-slip from lateral shear (e.g., San Andreas Fault system)



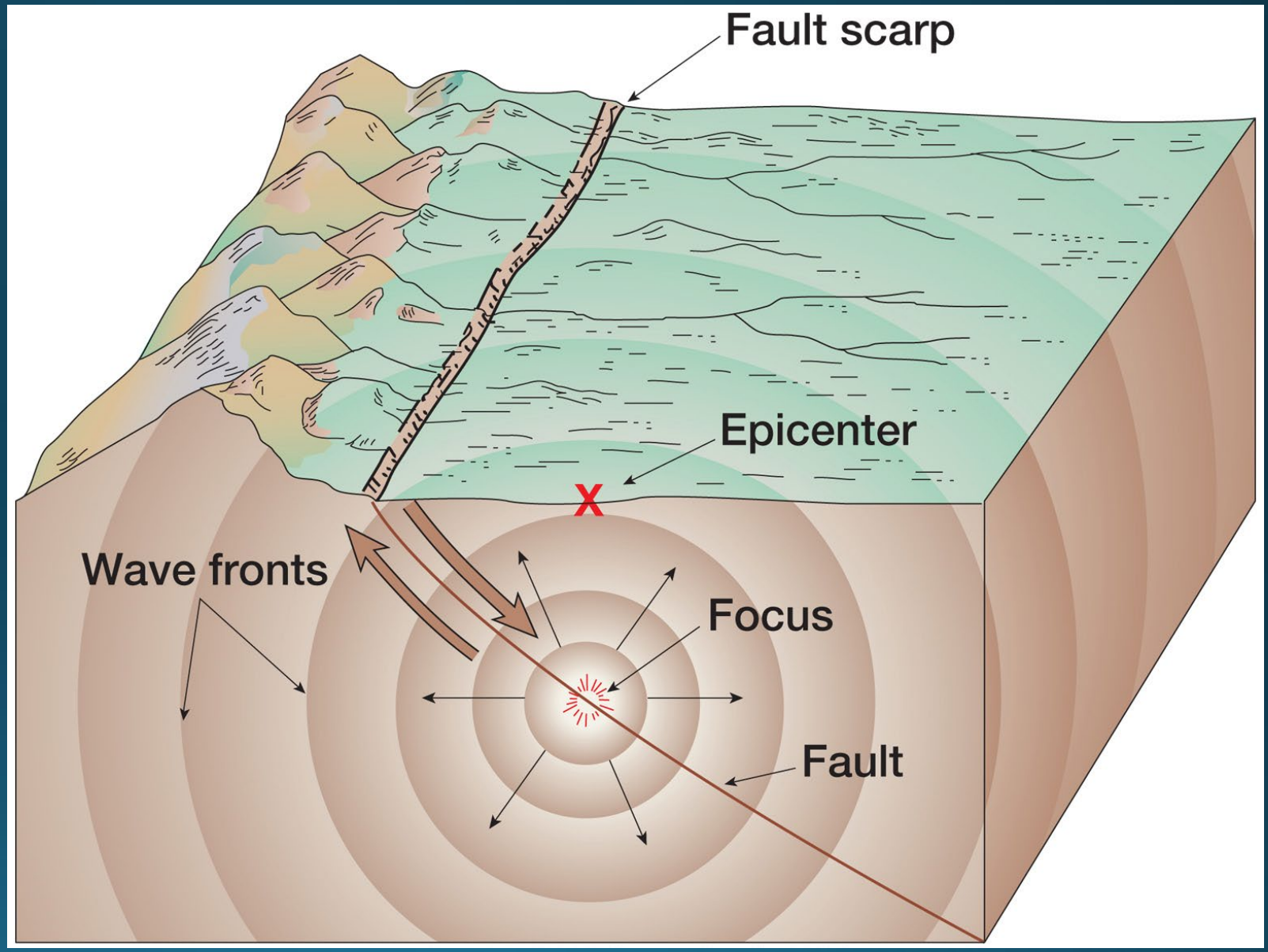
Faults & Earthquakes II

Faults are planes of weakness in the Earth's crustal rocks.

When sufficient stress accumulates, the rock will break –EARTHQUAKE; releasing seismic (energy) waves that propagate through surrounding rock causing ground shaking.

<u>Seismic wave velocities</u>
Surface waves - 2-3 km/s;
Body waves 4-6 km/s

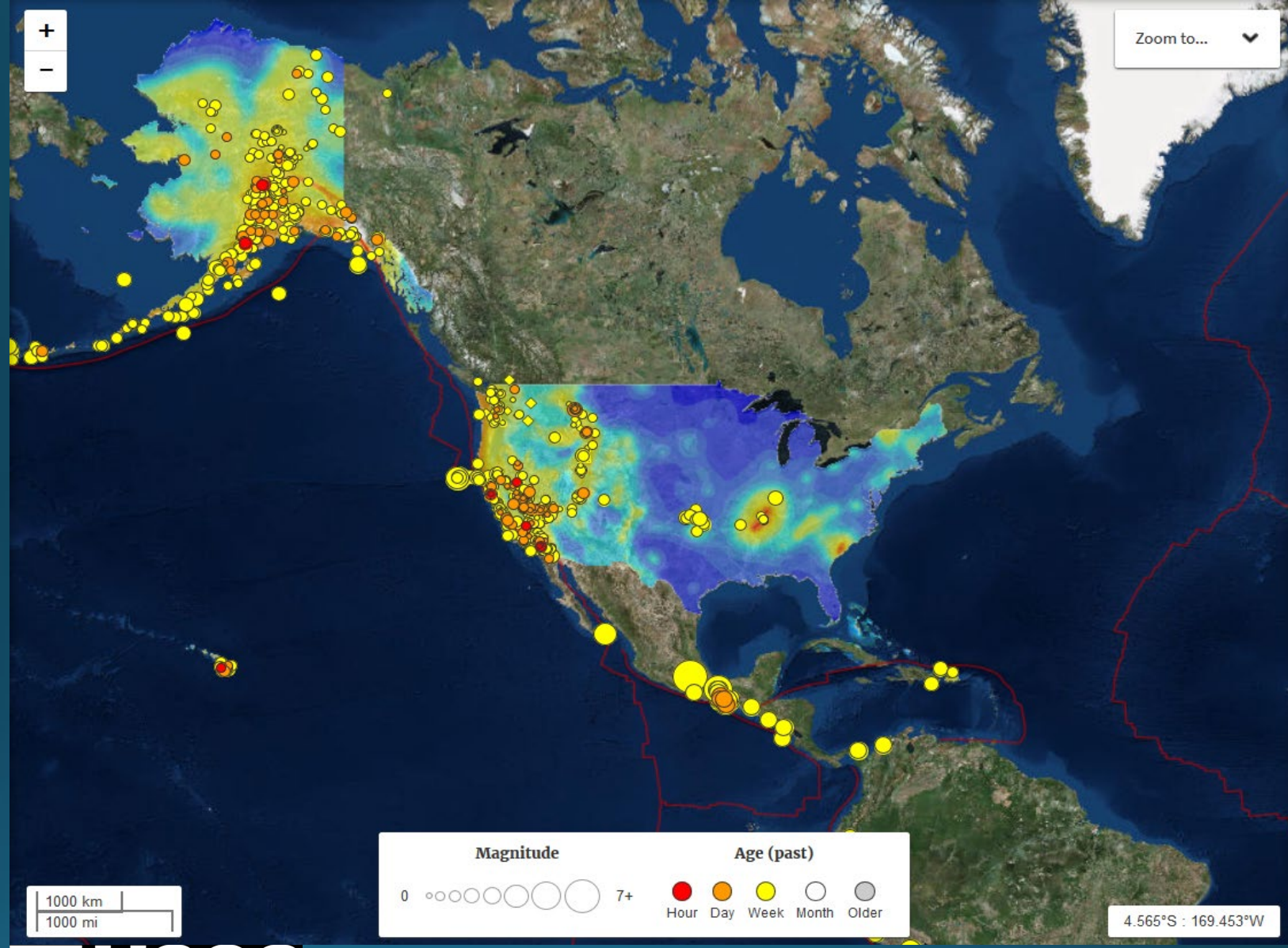
Speed of sound ~ 0.34 km /s



A week in the tectonic life of US & Central America

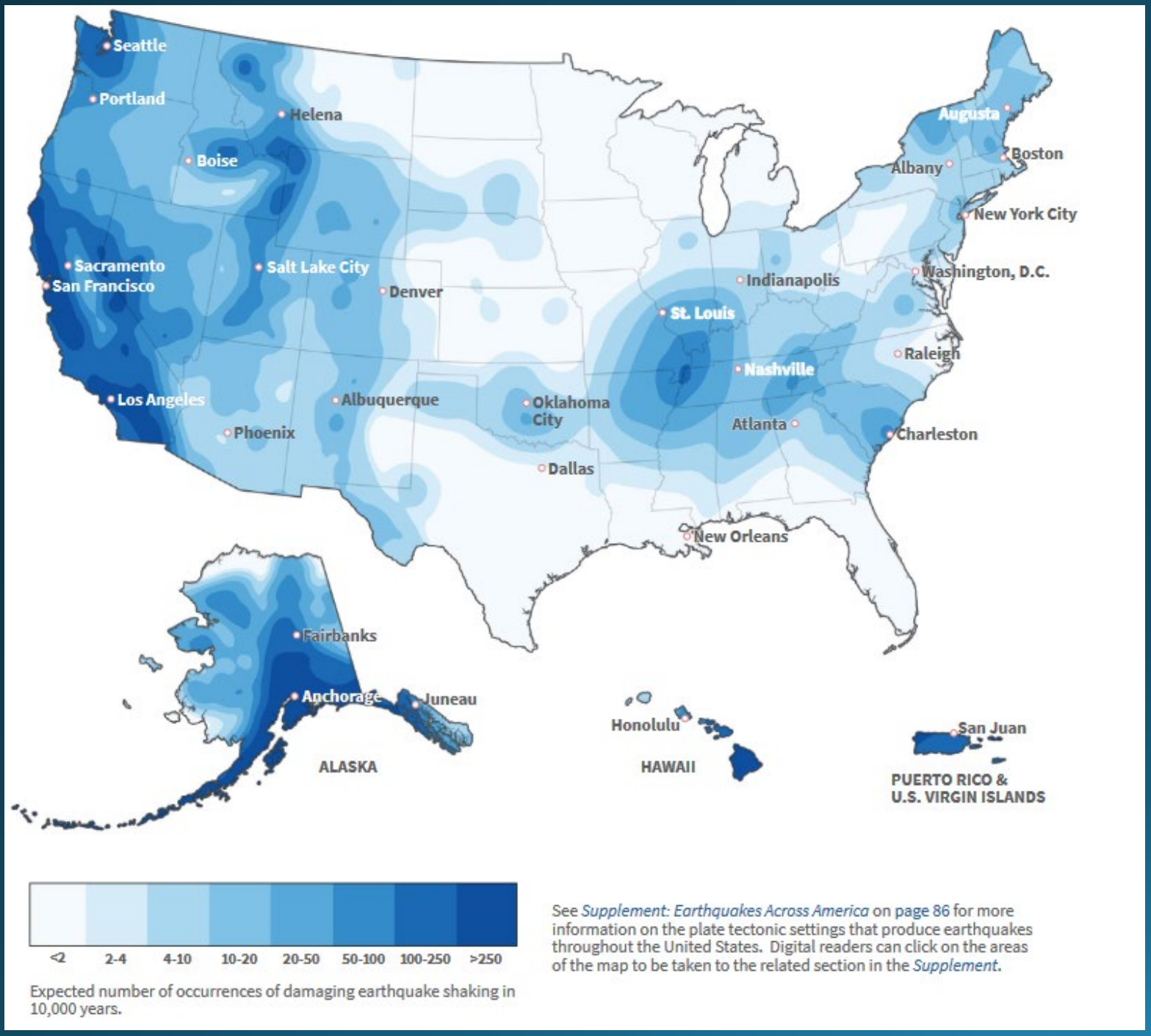
This image displays <u>all</u> earthquakes recorded in one 7-day period (9/18 – 9/25 2019) by the USGS seismic and partner network(s). The majority were < M2.5 and thus were not felt.

The color ramp reflects the level of seismic hazard:
red to orange – high to moderate;
blue – low hazard.



USGS science for a changing world

https://earthquake.usgs.gov/earthquakes/map/

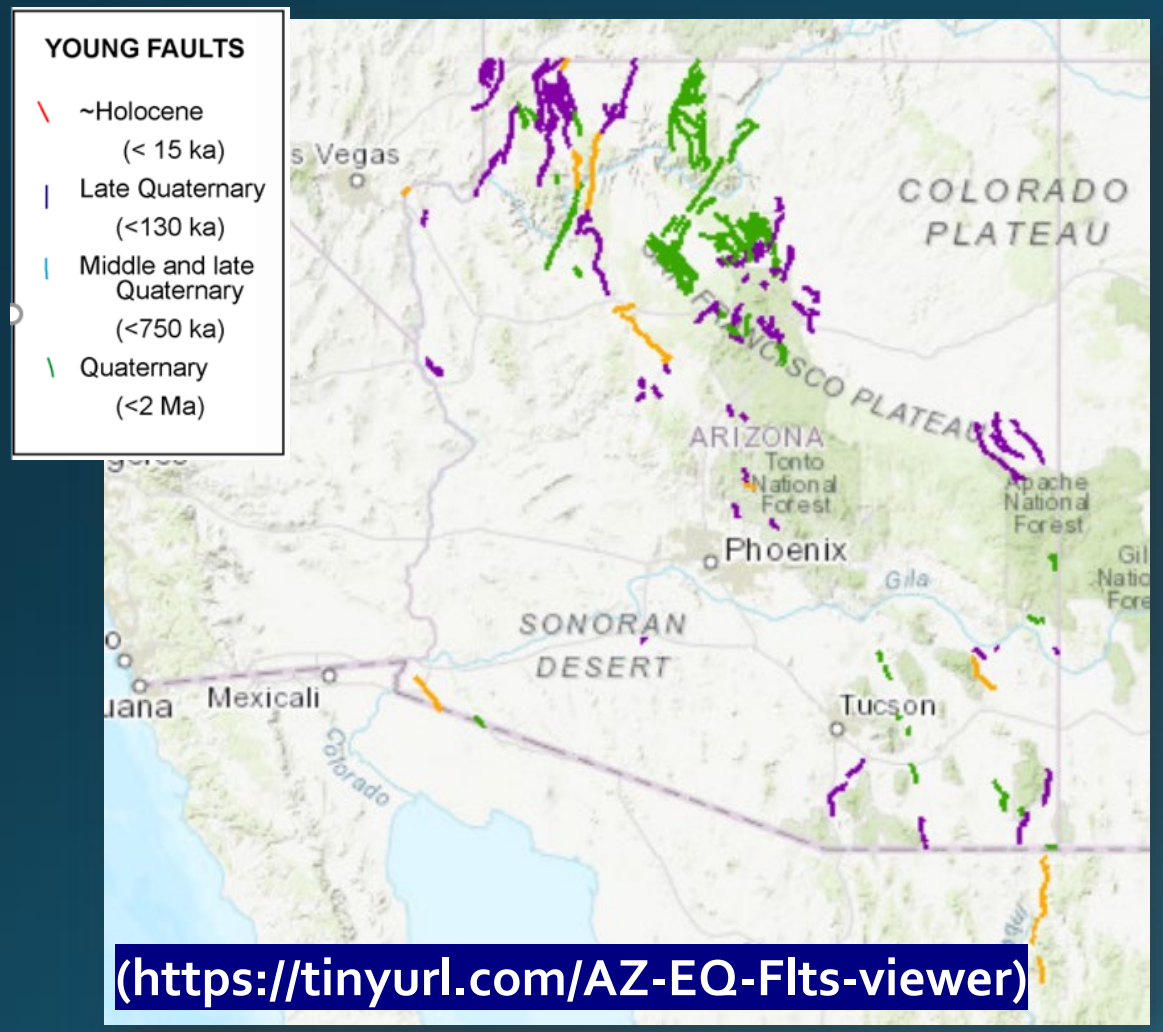


Color ramp illustrates the expected number of occurrences of damaging earthquake shaking in 10,000 years.

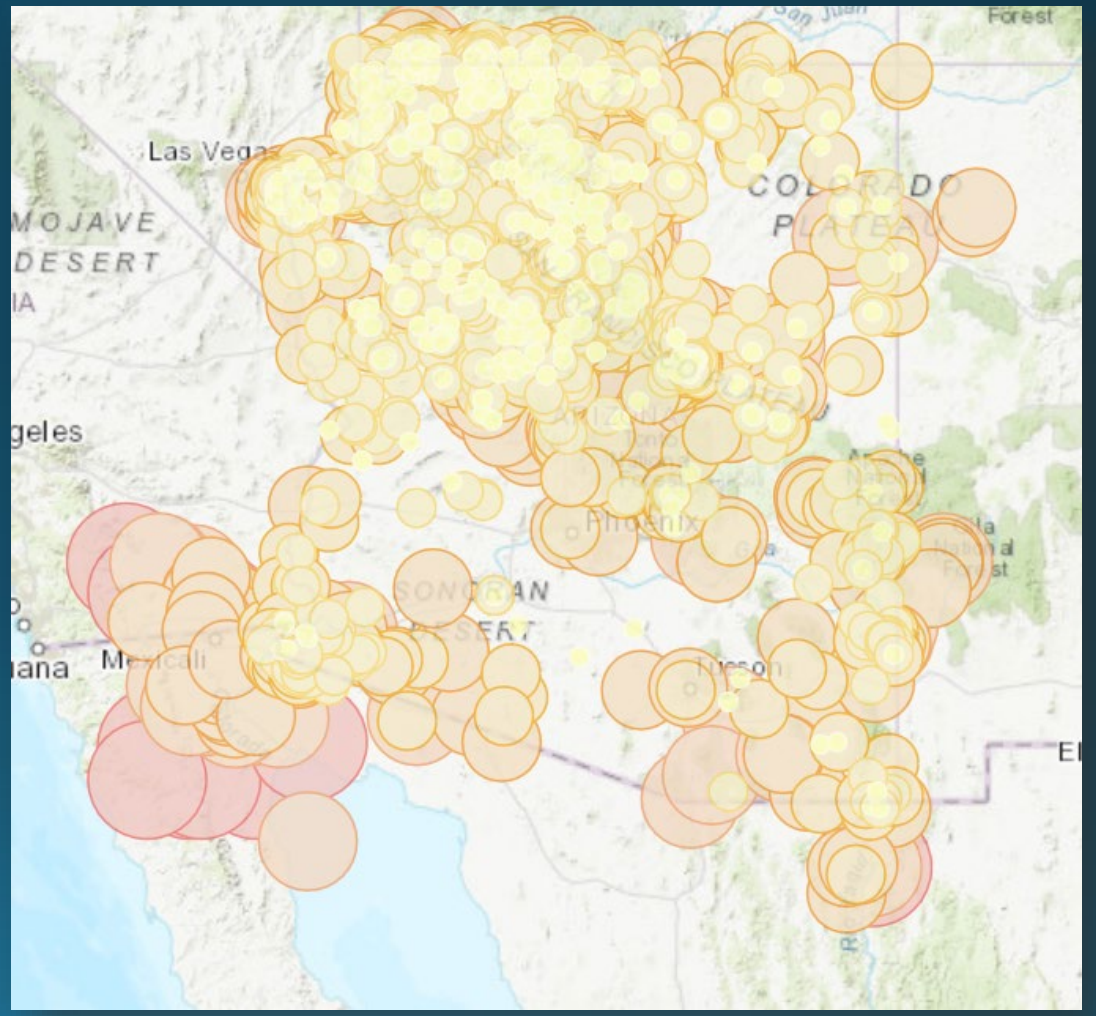
Source:
FEMA P-530: Earthquake Safety at Home

Tracking Arizona Faults & Earthquakes

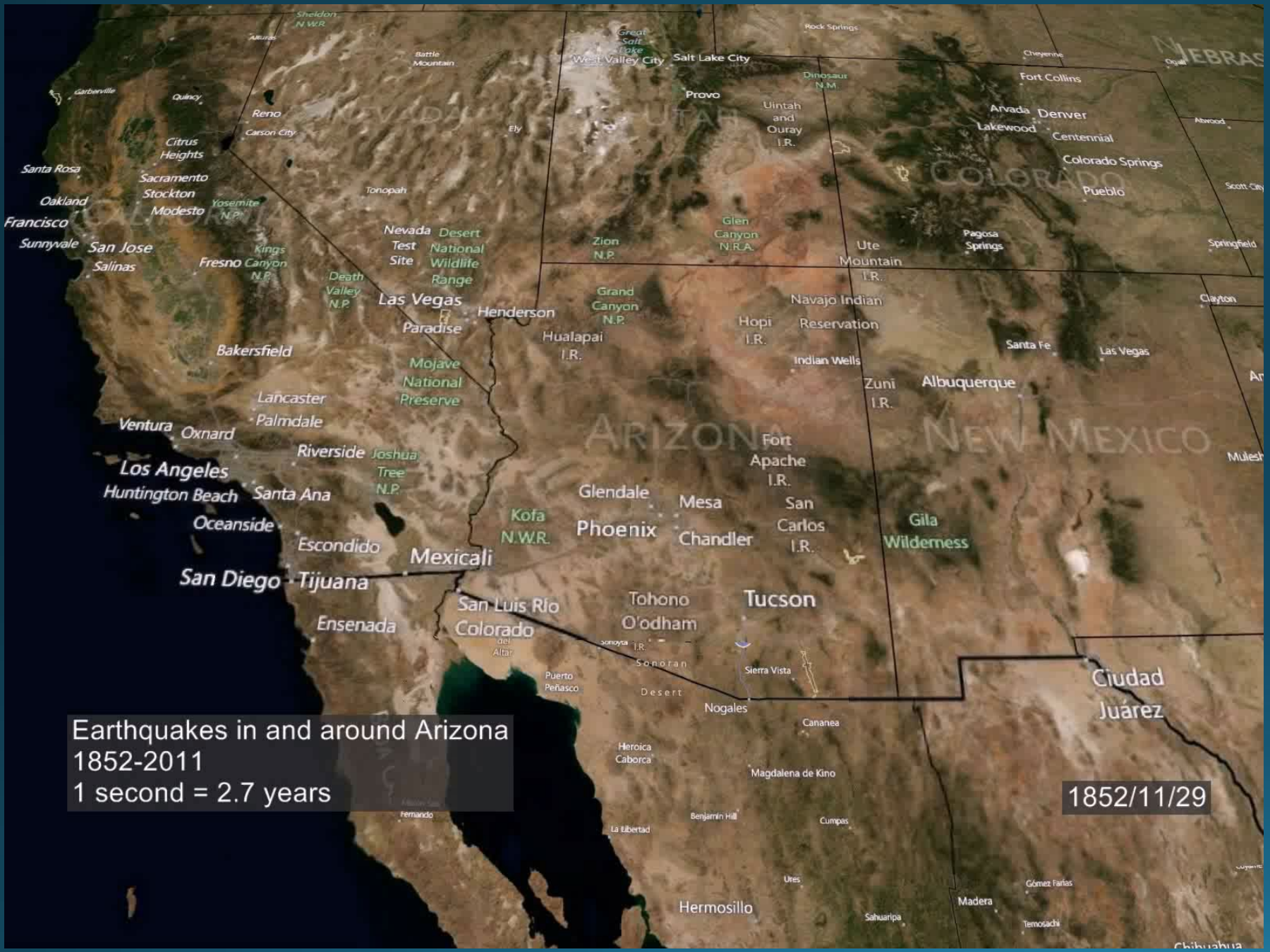
Natural Hazards in Arizona interactive viewer



Quaternary faults



Earthquakes epicenters 1852-2020



Historic earthquakes time-lapse video

https://tinyurl.com/AZEQ-Video

1 second is equal to 2.7 years. The larger the starburst the larger the magnitude of the event.

The prominent increase in events in the final decade of the 20th century and first decade of 21st century results from increasing the number of seismometer deployed in Arizona.

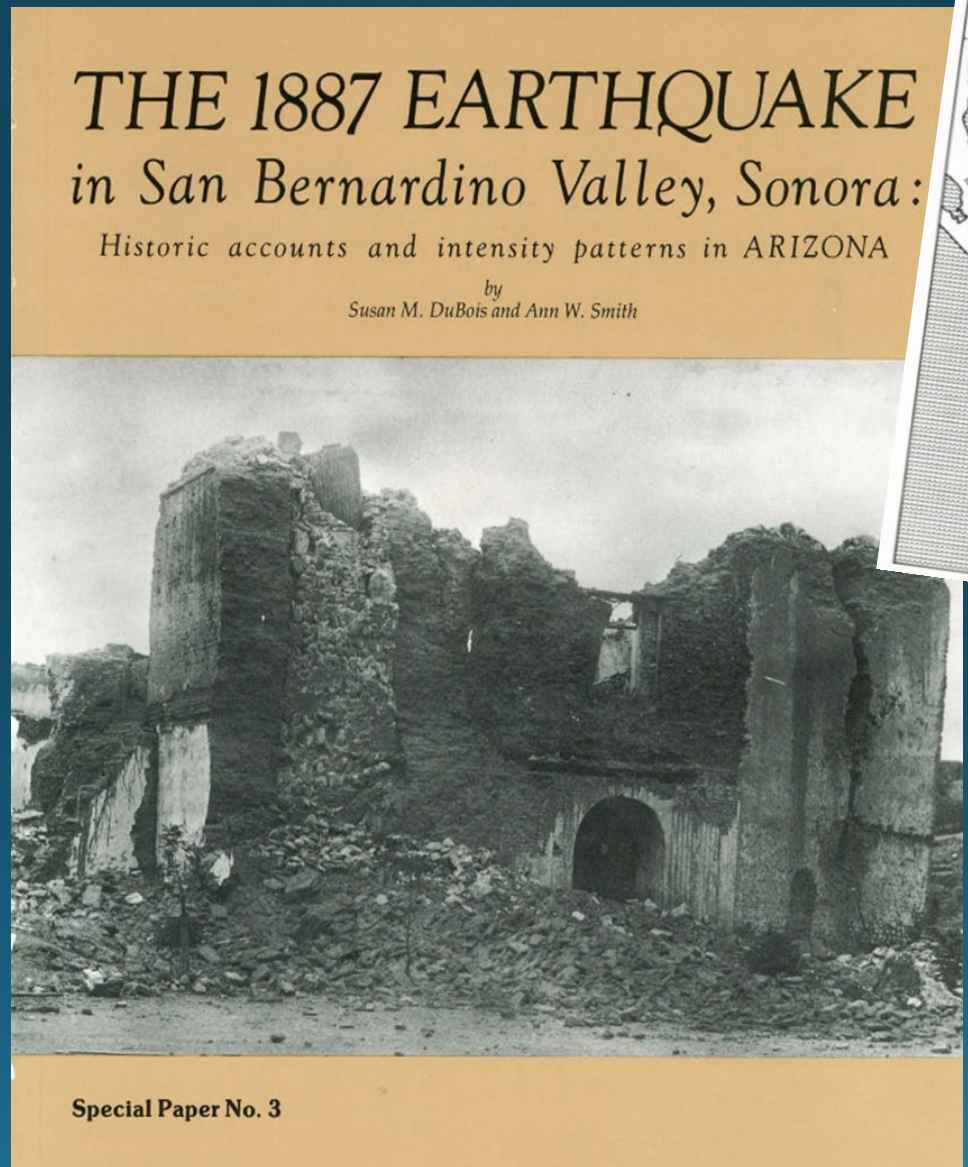
ARIZONA GEOLOGICAL SURVEY AZGS

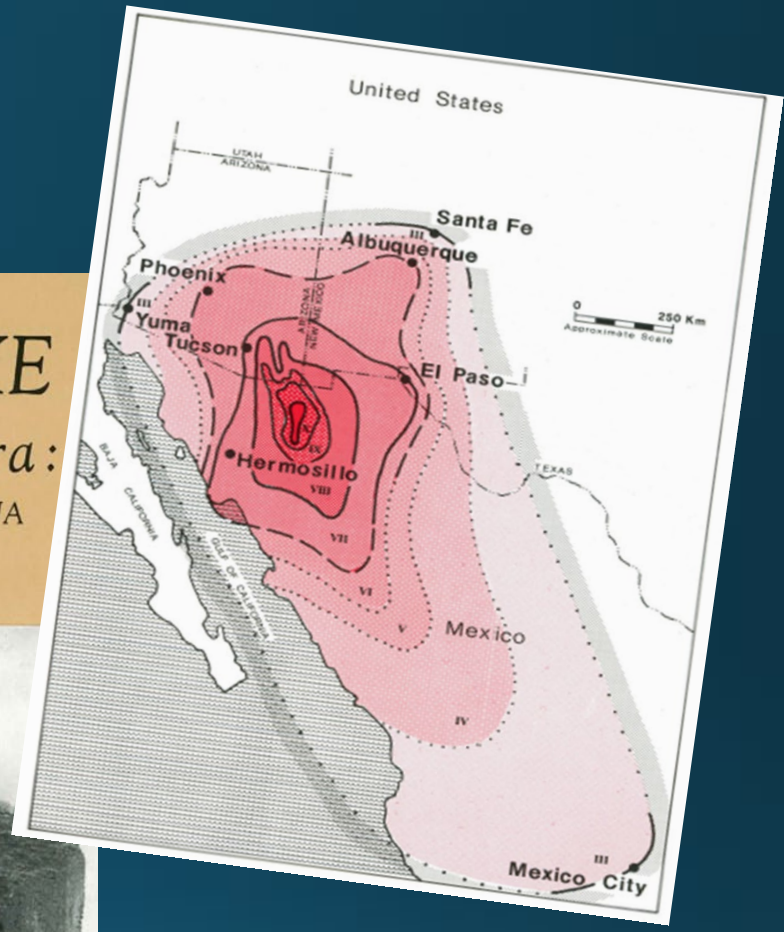
Arizona's 'BIG ONE's

4 May 1887 Great Sonoran Earthquake

More than 50 people were killed in Sonora, Mexico, as a result of collapse of the cathedral shown on the cover of this report.

- Magnitude ~ 7.5
- 100 km-long ground rupture
- Northern end ~10 km south of Arizona border
- Ground shaking widely felt throughout AZ, MX, NM.

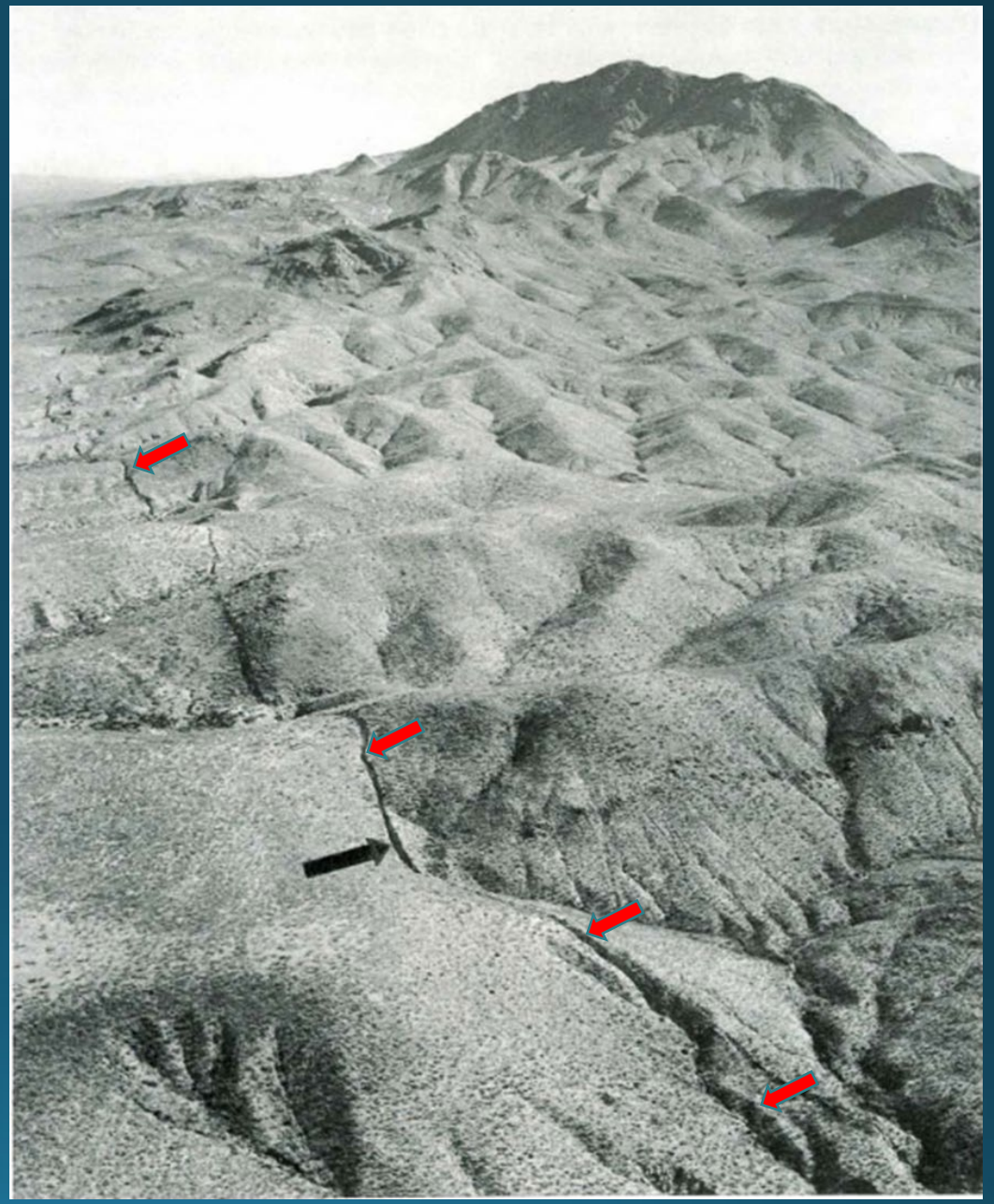




https://tinyurl.com/1887-SonoranEQ

1887 Great Sonoran Earthquake

Fault scarp of the 1887 Great Sonoran Earthquake, maximum displacement of ~ 4 meters between upthrown and downthrown blocks.



Ground rupture along the trace of the fault marked by Red and black arrows.

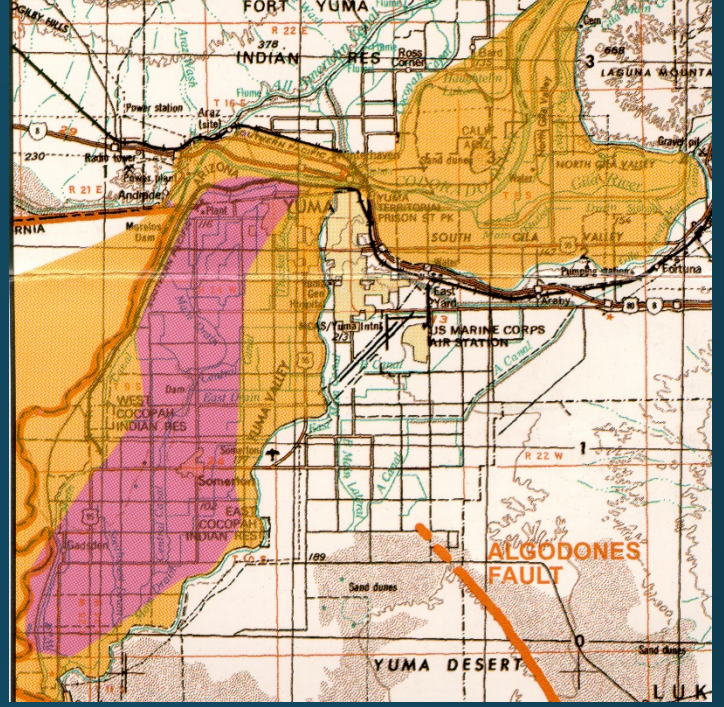
Imperial Fault, CA M7.1 event

Imperial Valley CA, 8 May 1940

Imperial Fault, CA M7.1

Imperial Valley, 8 May 1940

Pancaked building with a broken back
Brawley, CA



Extensive liquefaction in Yuma Valley 1940 EQ.

Liquefaction occurs when water saturated soils behave like a fluid.

Impacts of M 6.5 to 7.0+ Earthquake

- Very strong to strong ground shaking
- Felt aftershocks – Days | W | M | Years
- Damage to roads and bridges
- Damage/Collapse of some *URM buildings
- Water & gas mains disrupted – FIRE
- Critical facilities disrupted – H / S / P
- Few fatalities but numerous injured
- Communications disrupted
- 1o,ooos without power
- Damage to rail lines
- Landslides

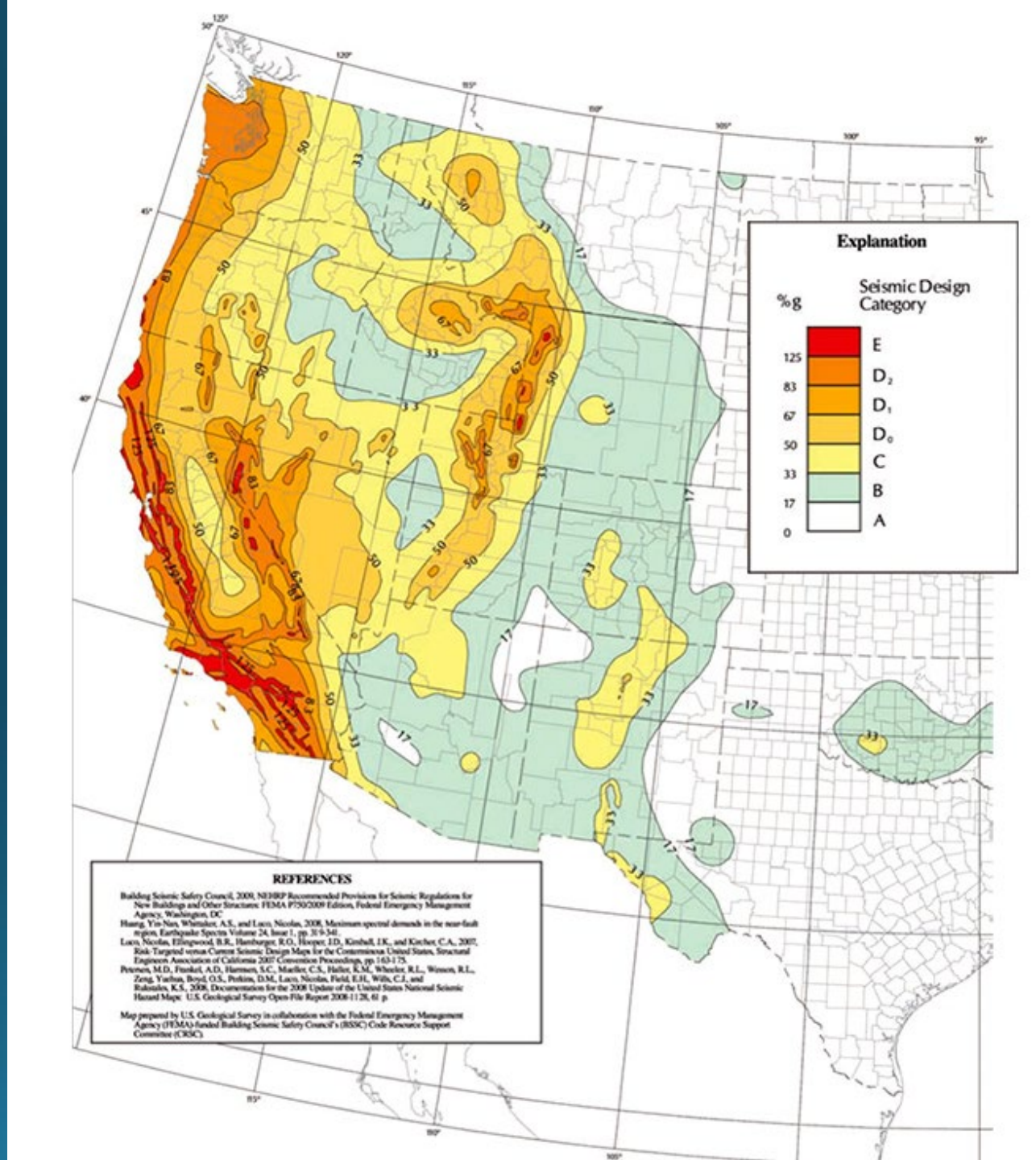
*URM – unreinforced masonry building

Engineering for Earthquakes

FEMA Seismic Design Category A - E

Yuma Arizona

More stringent building code (C-D2)



NEHRP Recommended Seismic Provisions

for New Buildings and Other Structures

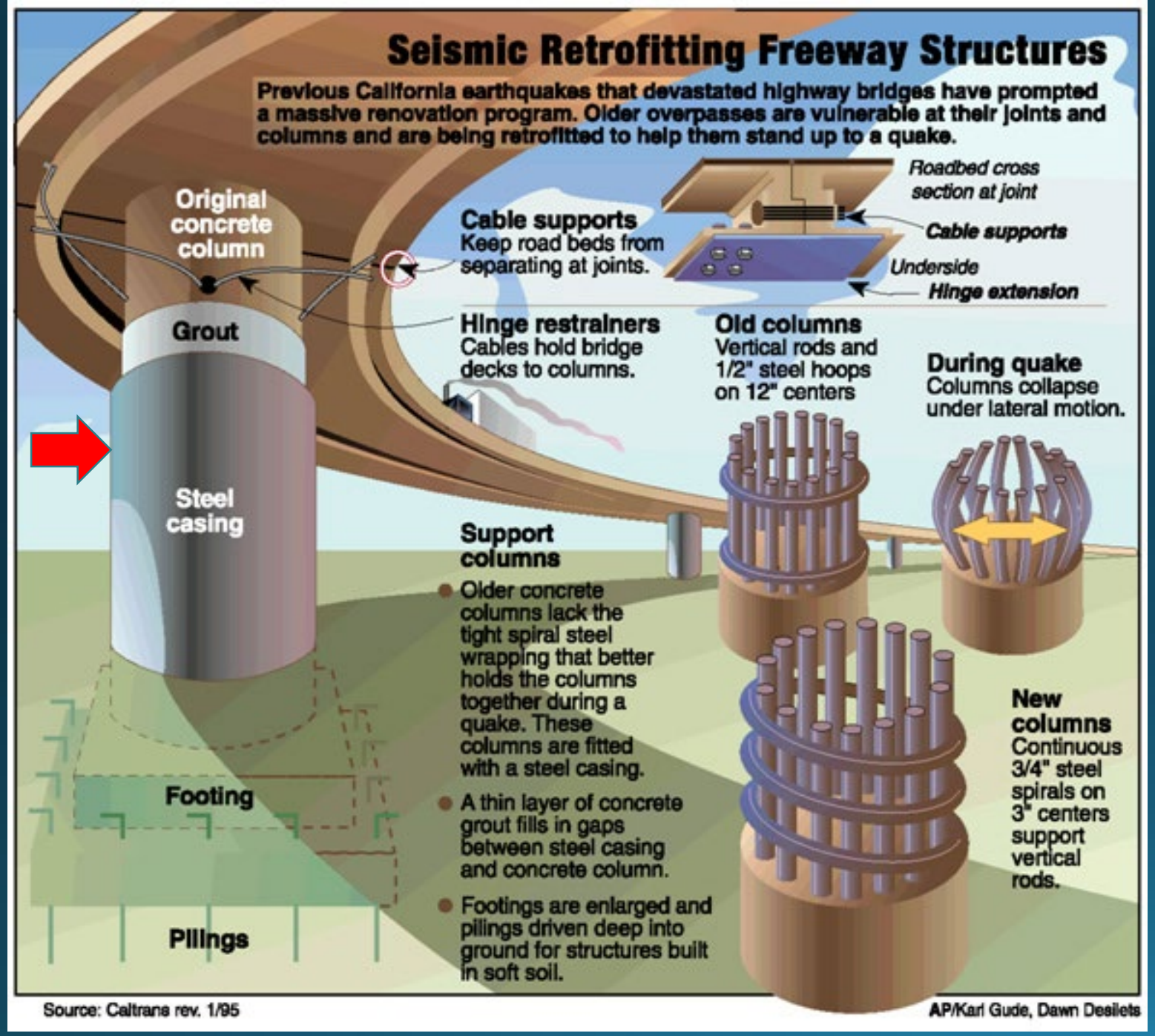
FEMA P-750 / 2009 Edition

Earthquakes:
A nationwide geohazard

FEMA to the rescue with help from EERI and State, County, Tribal and Municipal emergency management teams.

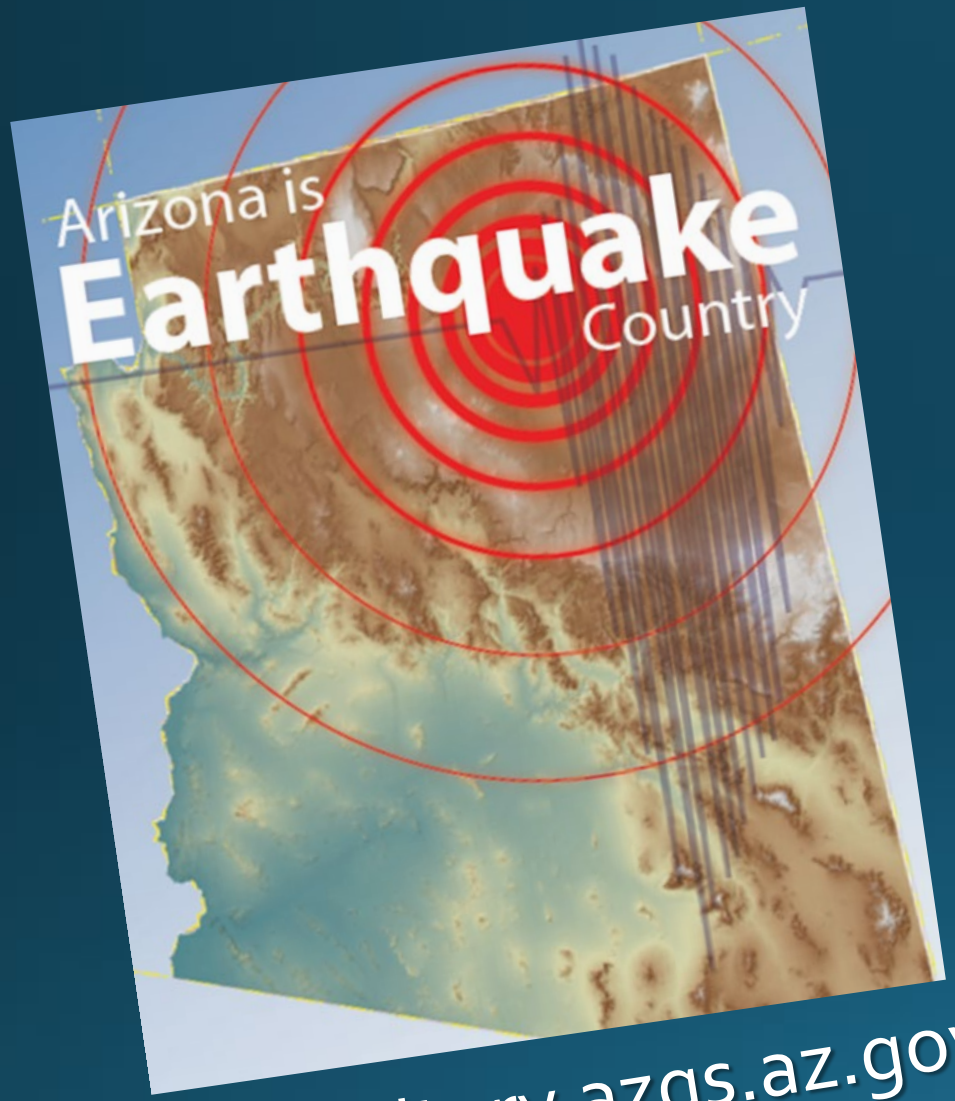
Earthquake Engineering Research Institute

Dedicated to reducing earthquake risk



Skirting Yuma's Bridges

Earthquake preparedness



Repository.azgs.az.gov

The Seven Steps to Earthquake Safety

BEFORE A QUAKE:

STEP 1. Identify potential hazards in your home and fix them (p. 12-13).

STEP 2. Create a disaster-preparedness plan (p. 14-15).

STEP 3. Prepare disaster supply kits (p. 16-17).

STEP 4. Identify your building's potential weaknesses and begin to fix them (p. 18-19).

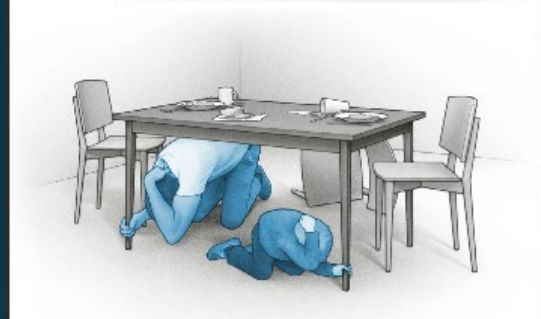
DURING A QUAKE:

STEP 5. Protect yourself during earthquake shaking (p. 20-21).

AFTER A QUAKE:

STEP 6. After the earthquake, check for injuries and damage (p. 22-23).

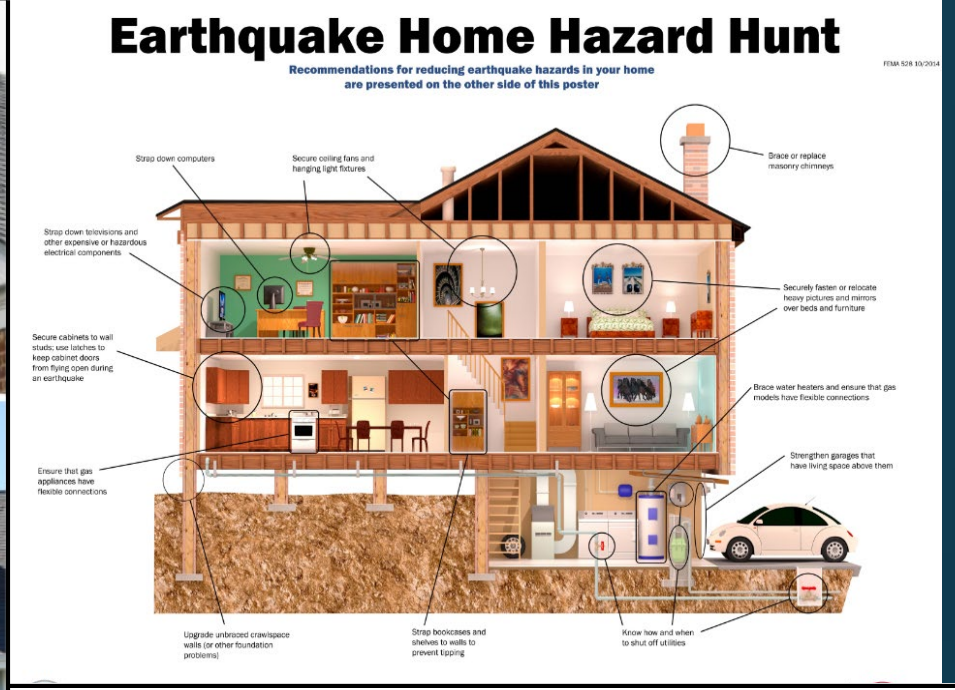
STEP 7. When safe, continue to follow your disaster-preparedness plan (p. 24-25).

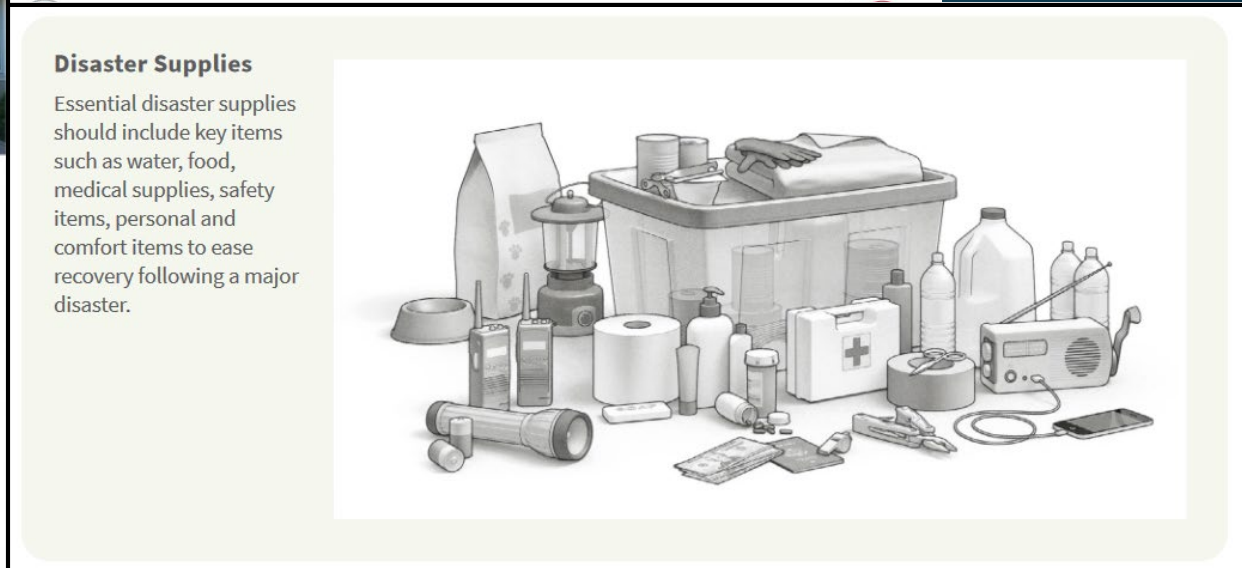


https://tinyurl.com/EQSafetyAtHome-FEMA

Earthquake Safety at Home

FEMA P-530 / March 2020





110-page document for general public use

https://tinyurl.com/EQSafetyAtHome-FEMA

Earthquake Safety Checklist

FEMA B-526 / November 2017

Download here

Ready

FEMA

Are You READY!

Some disasters strike without any warning. Have you thought about those supplies you'll need the most? They will usually be the hardest to come by. Enlist your children to help gather supplies for your family's emergency kit. It'll bring you a sense of relief, and your kids a feeling of empowerment.

Make sure you have enough supplies to last for at least **three days**. Think about where you live and your needs. Consider having a large kit at home, and smaller portable kit in the car or your workplace.

Emergency Supplies Lis

- ☐ 3-day supply of non-perishable food (dried fruit, canned tuna fish, peanut butter, etc.)
- ☐ Can opener
- ☐ Paper plates, plastic cups and utensils, paper towels
- ☐ Moist towelettes, garbage bags and plastic ties for personal sanitation
- ☐ Water – at least a gallon per person, per day for drinking and hygiene
- ☐ First aid kit
- ☐ Prescription medication and glasses
- ☐ Sleeping bag or warm blanket for everyone in your family
- ☐ Change of clothes to last for at least 3 days, including sturdy shoes; consider the weather where you live
- ☐ Matches in a waterproof container
- ☐ Toothbrush, toothpaste, soap and other personal items
- ☐ Feminine hygiene supplies
- ☐ Fire extinguisher
- ☐ Wrench or pliers to turn off utilities
- ☐ Dust mask, and plastic sheeting and duct tape, to help filter contaminated air
- ☐ Battery-powered or hand-cranked radio and extra batteries
- ☐ Flashlights and extra batteries
- ☐ Cell phone with charger, extra battery and solar charger
- ☐ Whistle to signal for
- ☐ Household chlorine … diluted nine parts wa… …leach, bleach can be used as a disinfectant. Or in an emergency, you can use it to treat water by using 16 drops of regular household liquid bleach per gallon of water. Do not use scented, color safe or bleaches with added cleaners.)
- ☐ Local maps
- ☐ Cash or traveler's checks
- ☐ Emergency reference material such as first aid book or information from www.ready.gov
- ☐ Important family documents such as copies of insurance policies, ID, and bank records in a waterproof, portable container
- ☐ Pet supplies
- ☐ Infant formula and diapers
- ☐ Paper and pencil
- ☐ Books, games or puzzles (let your kids pick these out themselves!)
- ☐ Your child's favorite stuffed animal or security blanket
- ☐ Pet food and extra water for your pet

Don't forget to think about infants, elderly, pets, or any family members with special needs!

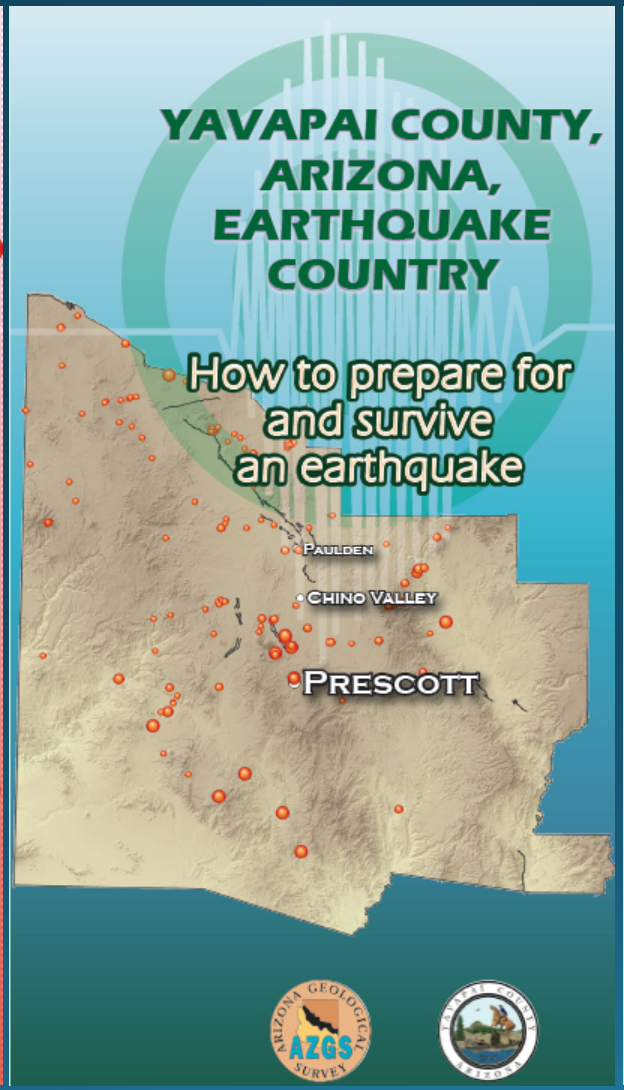
AZGS Earthquake Services

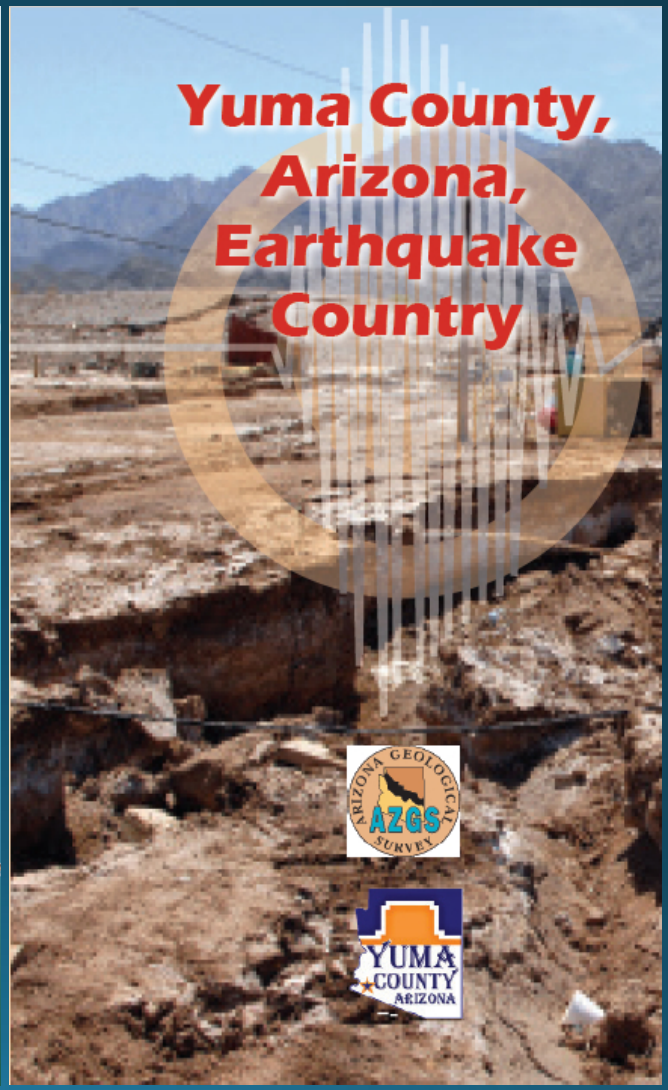
- AZ Broadband Seismic Network
- Natural Hazards in AZ Viewer
- Great Arizona Shakeout
- ACES – AZ Council on Earthquake Safety

https://azgs.arizona.edu/

County Earthquake Flyers: Preparing for & Surviving Eqs!

Coconino, Yavapai and Yuma Counties





Download at http://repository.azgs.az.gov/

Haikus inspired by the 2011 Tōhoku earthquake and tsunami

□ □ □ □ □ □ □ □ □ □ □ □ □ □ □

uchitsuzuku nai no hanmā sunaarashi

the endless hammering
of earthquakes—
sand storm

□ □ □ □ □ □ □

□ □ □ □ □ □ □ □ □

hinanjo ni haru kuru
kyatchbōru kana

spring comes
to a refugee camp . . .
playing catch

□ □ □ □ □ □ □ □ □ □ □ □ □ □ □

nagasarete mō naihazu no hashi oboro

washed away
the bridge that is no longer there
in the mist

□ □ □ □ □ □ □ □ □ □ □

tsubame kite hito kieru machi hibakuchū

swallows arrive
and people disappear from the town
radiation exposure

□ □ □ □ □ □ □ □ □ □ □ □ □ □ □

ōnai no ato no shundei namagusashi

after the earthquake
the spring mud smells
fishy

http://www.graceguts.com/translations/fukushima

Michael Conway
Arizona Geological Survey
Univ. of Arizona
Tucson, AZ USA

fmconway@email.Arizona.edu

UA Science

Funding provided by NEHRP and Arizona Geological Survey