



HISTORICAL EARTHQUAKES IN NEVADA

Craig M. dePolo - Nevada Bureau of Mines and Geology



"Nevada... 150 Years of Resiliency"

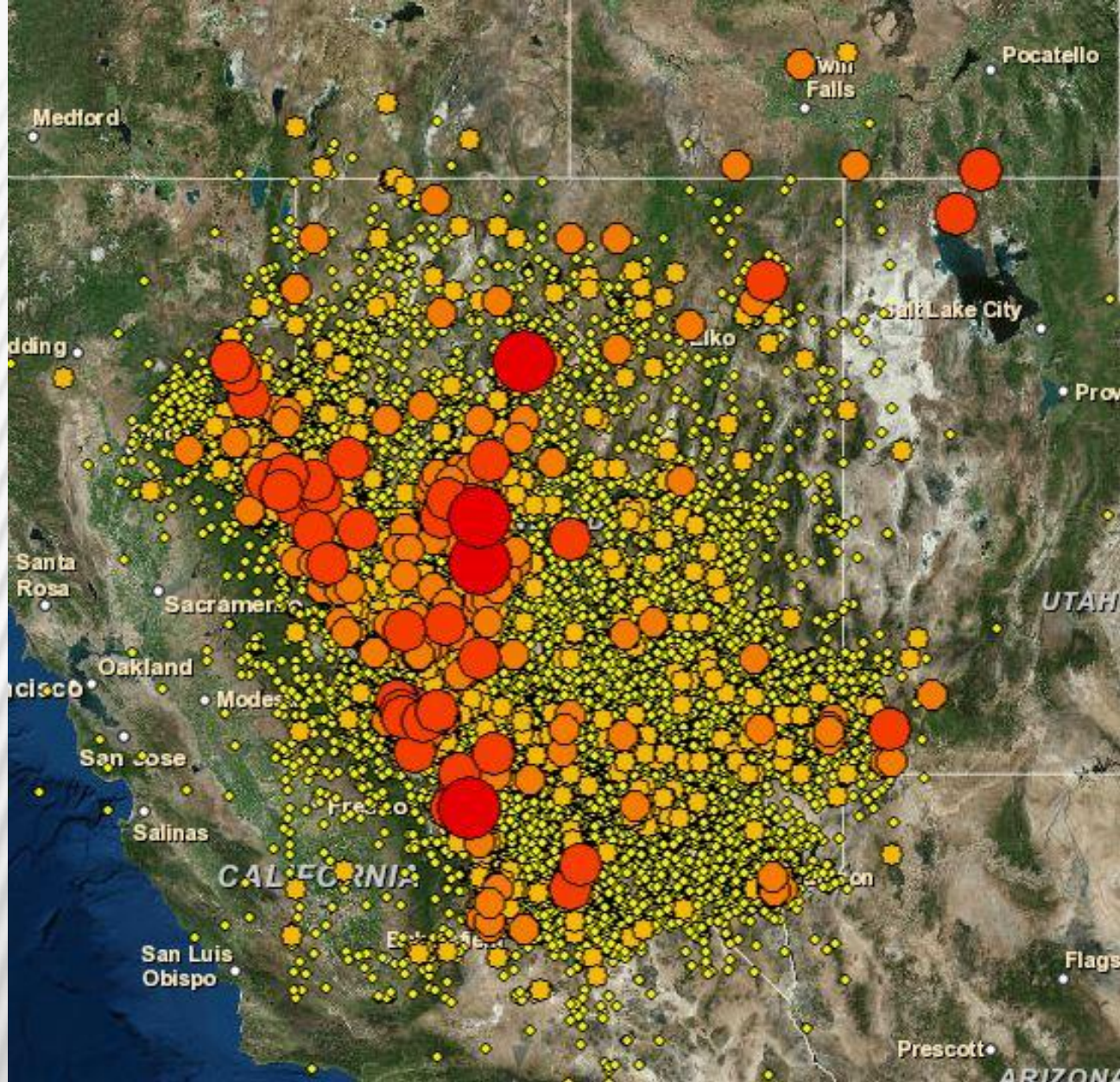
NEVADA IS EARTHQUAKE COUNTRY

- × Over 220,000 earthquakes have been recorded in and around the state since the 1850s.
- × 23 earthquakes from magnitude 6 to 7.3 during this ~160 years (third most active state).



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Earthquakes in and around Nevada 1850s to 2012



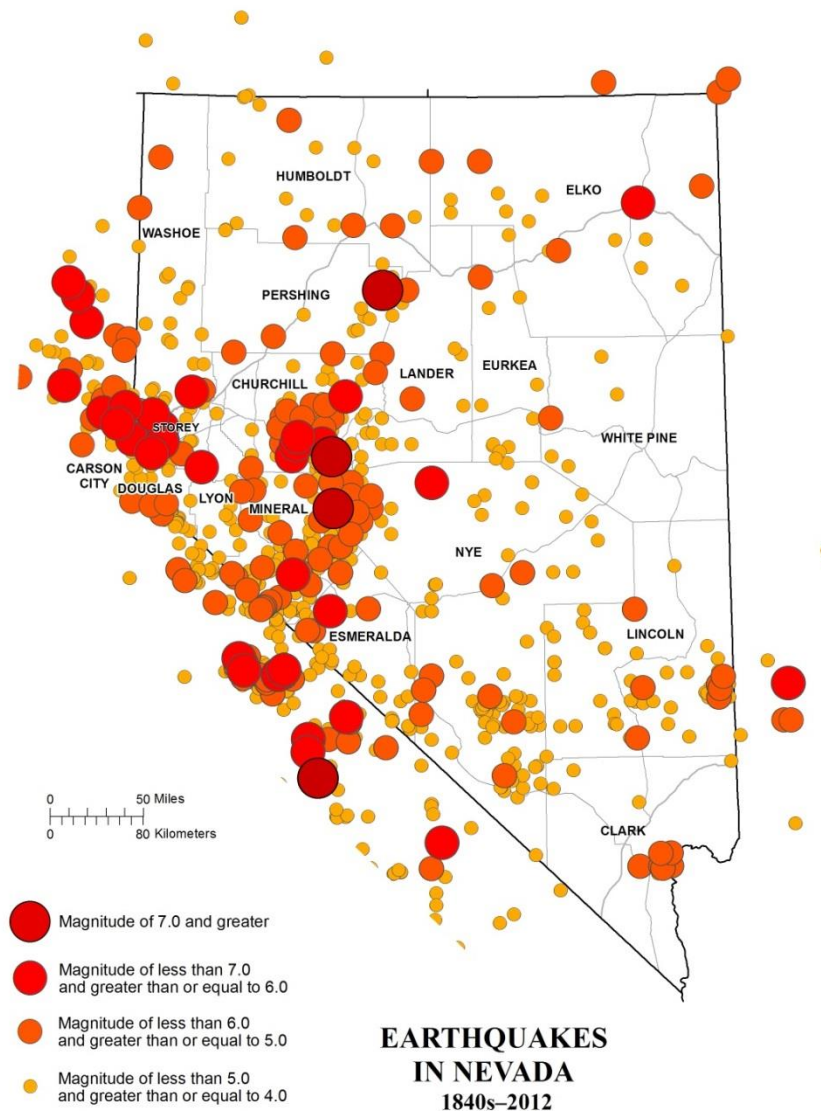
MyPlan website



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gisweb.unr.edu/myplan_nevada/

Magnitude 4 and greater Earthquakes in Nevada

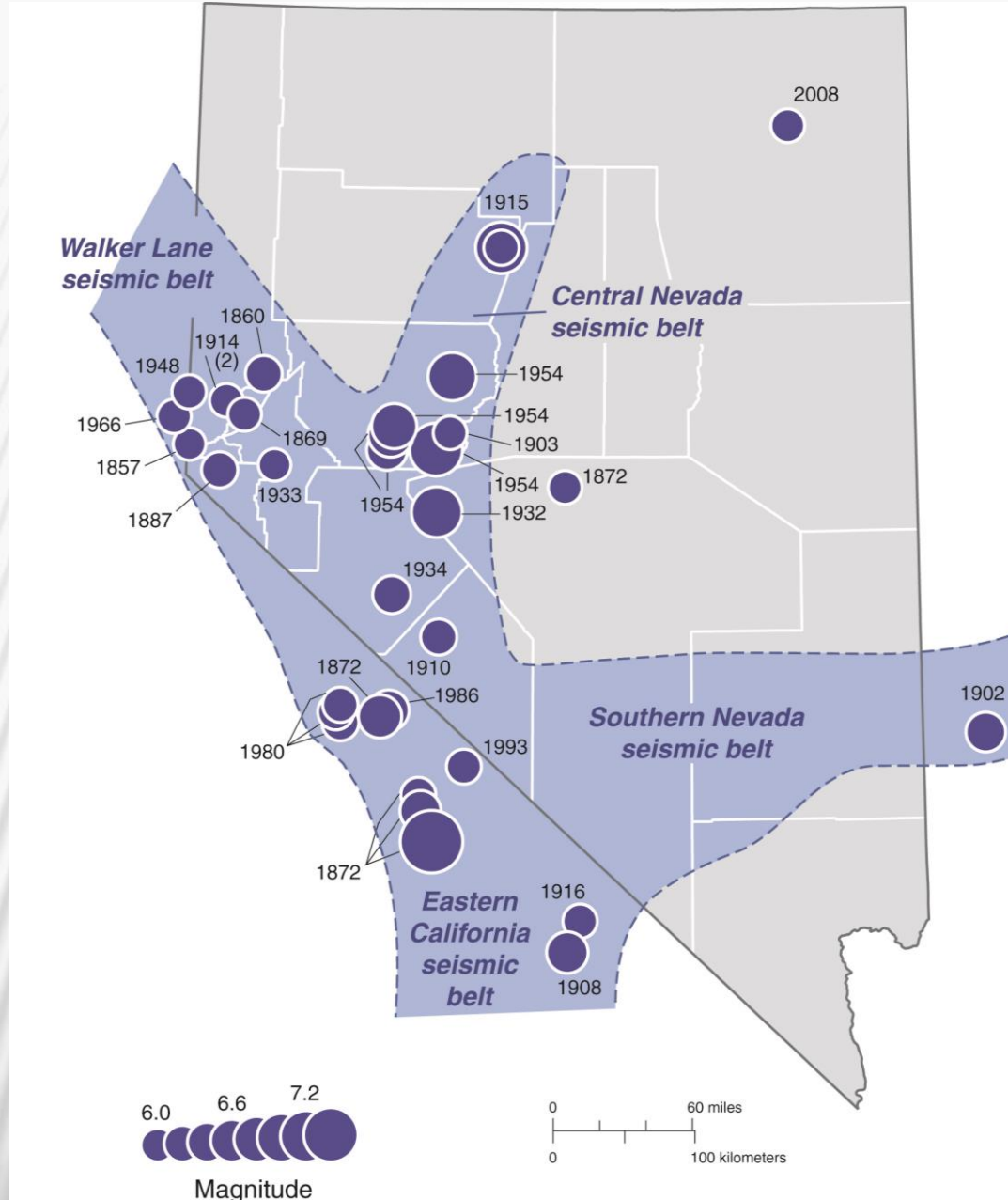


Earthquakes in the Nevada region recorded from the 1840s to 2012. (Nevada Seismological Laboratory)



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Seismic Belts In Nevada



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PRE-1900 MAJOR EARTHQUAKES

<u>Year</u>	<u>Mag.</u>	<u>Location</u>	<u>State</u>	<u>Elapsed Time NV M6+</u>
1790s?	7+?	Owens V. region	CA	-
1840s	7?	N-central NV	NV	-
1852?	6+?	Pyramid Lake	NV	-
1855	6	Sierraville	CA	-
1857	6	N of L. Tahoe	CA-NV	-
1860	6.5	SW of Pyramid L.	NV	3 yr
1868(2)	6	S of Reno	NV	8 yr /20 sec
1869	6.4	S of Reno	NV	1.25 yr
1869	6.2	S of Reno	NV	8 hr
1872	5.5	Austin	NV	-
1872	7.9	Owens V.	CA	2.3 yr
1872	6.8	Owens V.	CA	(3.5 hr)
1872	6.3	N. Owens V.	CA	(8 days)
1872	6.8	Round V.	CA	(8 days)
1872	6?	Austin	NV	7 mo
1875	5+	Eureka	NV	-
1875	6.2	Diamond M.	CA	(2.75 yr)
1885	6.1	Susanville	CA	(10 yr)
1887	6.5	Carson City NV	15 yr	
1889	6.2	Susanville	CA	(2 yr)



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20TH CENTURY MAJOR EARTHQUAKES

<u>Year</u>	<u>Mag.</u>	<u>Location</u>	<u>State</u>	<u>Elapsed Time NV M6+</u>
1901	5	Elko	NV	-
1903	6?	Wonder	NV	16 yr
1910	6.1	S of Columbus M.	NV	2 yr
1914	6.0	Reno	NV	3.25 yr
1914	6.4	Reno	NV	65 days
1915	6.1	S of Winnemucca	NV	1.5 yr
1915	7.3	S of Winnemucca	NV	5 hr
1916	6.1	E of Death V.	CA	(2.5 yr)
1932	7.1	Cedar M. NV		17 yr
1933	6.0	Wabuska NV		6 mo
1934	6.1	Excelsior M.	NV	5 mo
1948	6.0	Verdi	CA-NV	14 yr
1950	5.6	Fort Sage M.	CA	-



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20TH CENTURY MAJOR EARTHQUAKES

<u>Year</u>	<u>Mag.</u>	<u>Location</u>	<u>State</u>	<u>Elapsed Time NV M6+</u>
1954	6.2	E of Fallon	NV	6 yr
1954	6.1	E of Fallon	NV	11 hr
1954	6.8	E of Fallon	NV	49 days
1954	7.1	Fairview P.	NV	3 mo
1954	6.8	Dixie V.	NV	4.3 min
1966	6.0	Truckee	CA	22 yr
1966	5.6	Caliente	NV	-
1980	6.1	Mammoth L.	CA	(14 yr)
1980	6.0	Mammoth L.	CA	(16 min)
1980	6.1	Mammoth L.	CA	(2.9 hr)
1980	6.2	Mammoth L.	CA	(1.8 days)
1986	6.4	Chalfant V.	CA	(6 yr)
1993	6.2	Eureka V. CA		(7 yr)



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21ST CENTURY MAJOR EARTHQUAKES

<u>Year</u>	<u>Mag.</u>	<u>Location</u>	<u>State</u>	<u>Elapsed Time M6+</u>
2008	6.0	Wells	NV	42 yr
2008	5.0	W of Reno	NV	



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2008 WELLS EARTHQUAKE

- ✖ Magnitude 6.0,
- ✖ 30 to 40 seconds of shaking (basin response),
- ✖ Began with a loud bang; explosion like,
- ✖ Epicenter was 5.6 mi NE; ruptured to within 1.2 mi of town,
- ✖ Early morning event.



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Photo by Jack Hursh



"Nevada... 150 Years of Resiliency"

Wells old town before the earthquake



"Nevada... 150 Years of Resiliency"

Wells old town after the earthquake

WELLS EARTHQUAKE DAMAGE

- ✖ 35 out of ~80 buildings damaged (44%),
- ✖ 10 had severe or heavy damage (13%),
- ✖ 3 out of ~450 homes were severely damaged,
- ✖ >60 chimneys were damaged (10-15%).







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"Nevada... 150 Years of Resiliency"



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Modified Mercalli Intensity
February 21, 2008
Wells, Nevada
Earthquake

The map shows the following streets and features:

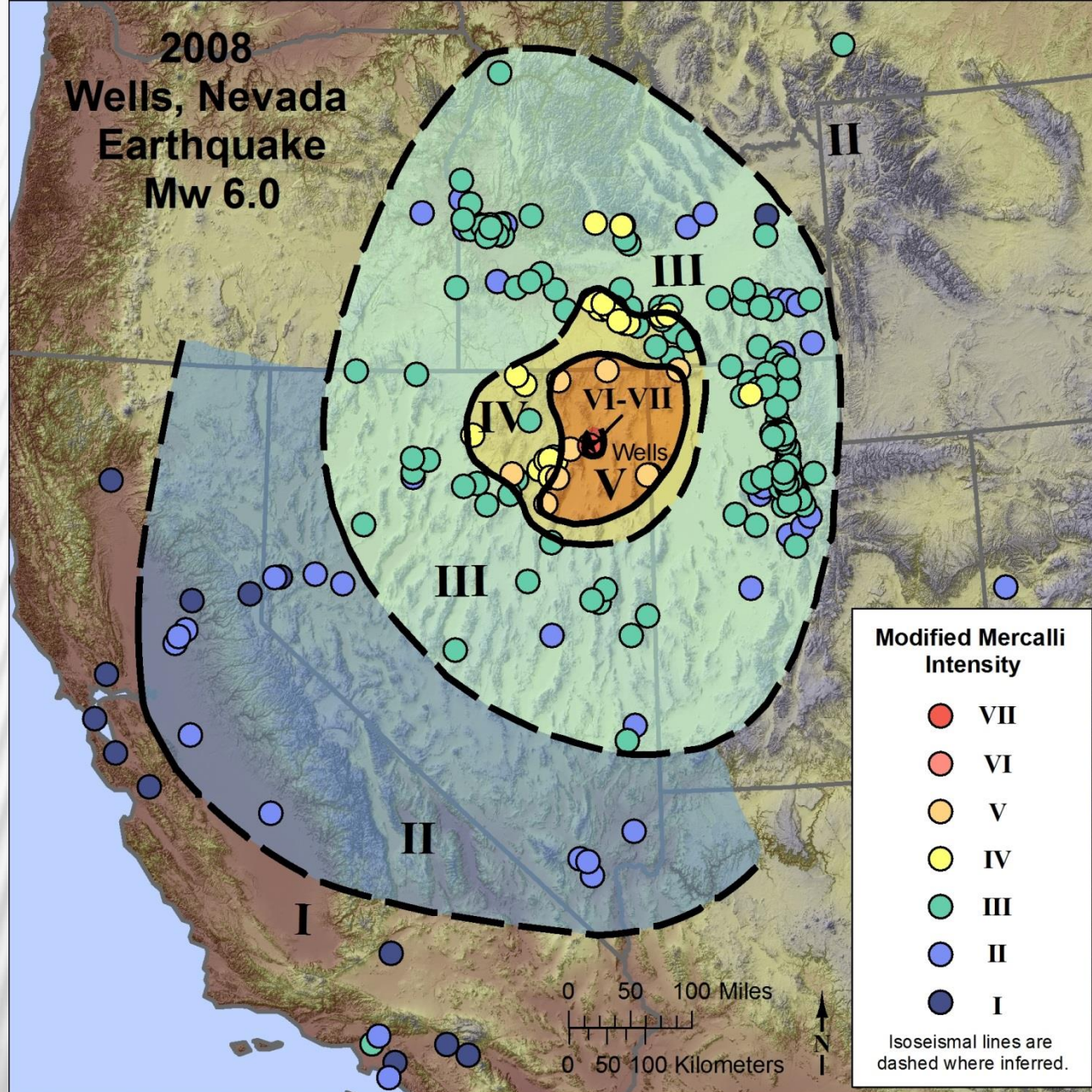
- Streets:** Mountain View Dr, Sixth St, Humboldt St, Pacific Ave, Union St, Western St, 1st St, 2nd St, 3rd St, 4th St, 5th St, 6th St, 7th St, 8th St, 9th St, 10th St, Hamilton St, Tobar St, Hogan St, Salduro St, Moor St, Cobre St, Edgewood Ave, Skoshone Ave, Ruby Ave, Colver Ave, Starr Ave, Lake Ave, Castle St, Dover St, Easy St, Ventosa St, I-80 Frontage Rd.
- Intensity Zones:**
 - Zone VIII (Red):** Centered in the town of Wells.
 - Zone VII (Black dashed outline):** Covers a large area including the town and surrounding regions.
 - Zone VI (Yellow):** In the western and southern parts.
- Other Features:** A dashed line with a question mark indicates the boundary of the study area. The map is titled "Modified Mercalli Intensity February 21, 2008 Wells, Nevada Earthquake".



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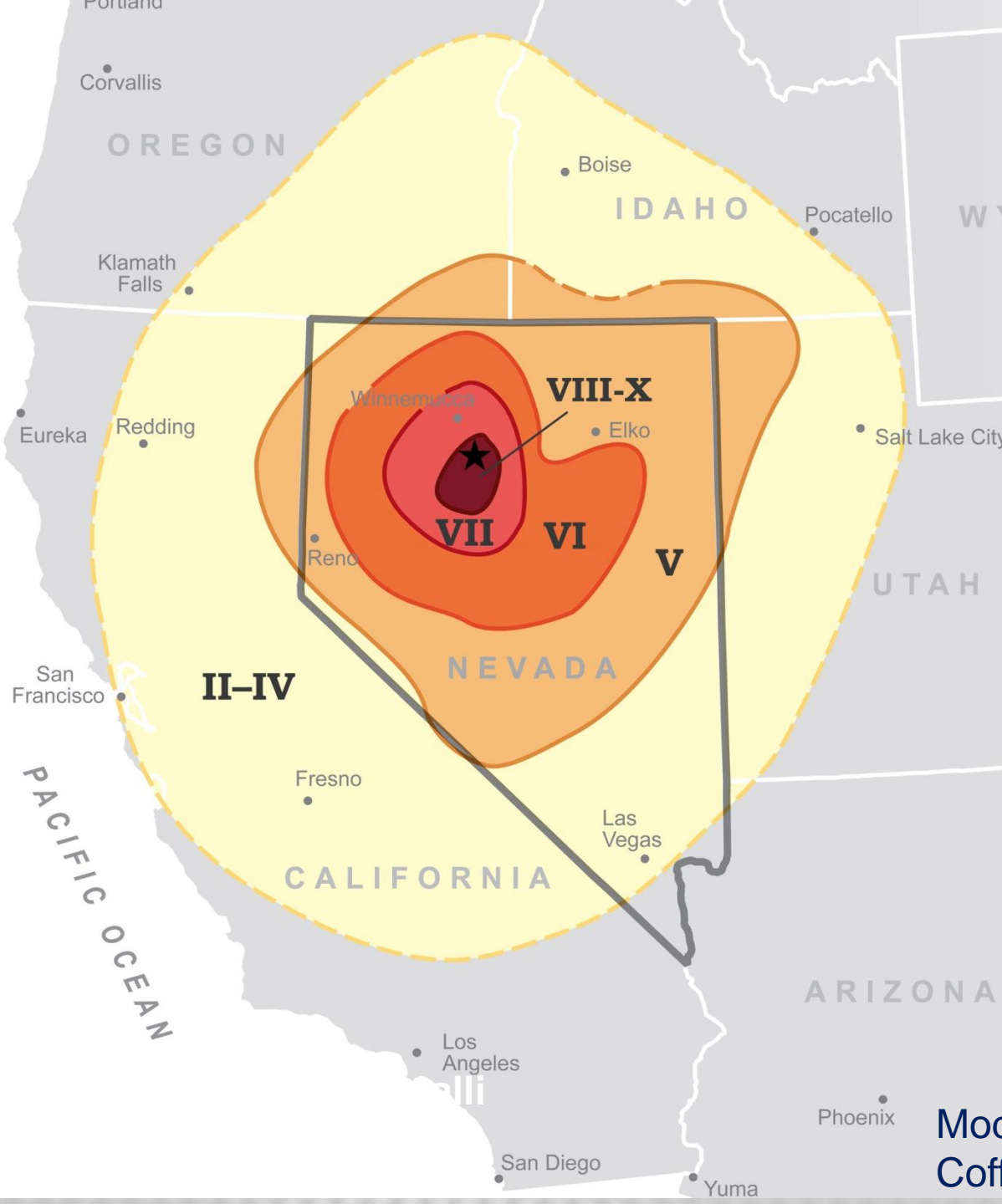
Transportation data provided by NDOT

2008 Wells, Nevada Earthquake Mw 6.0



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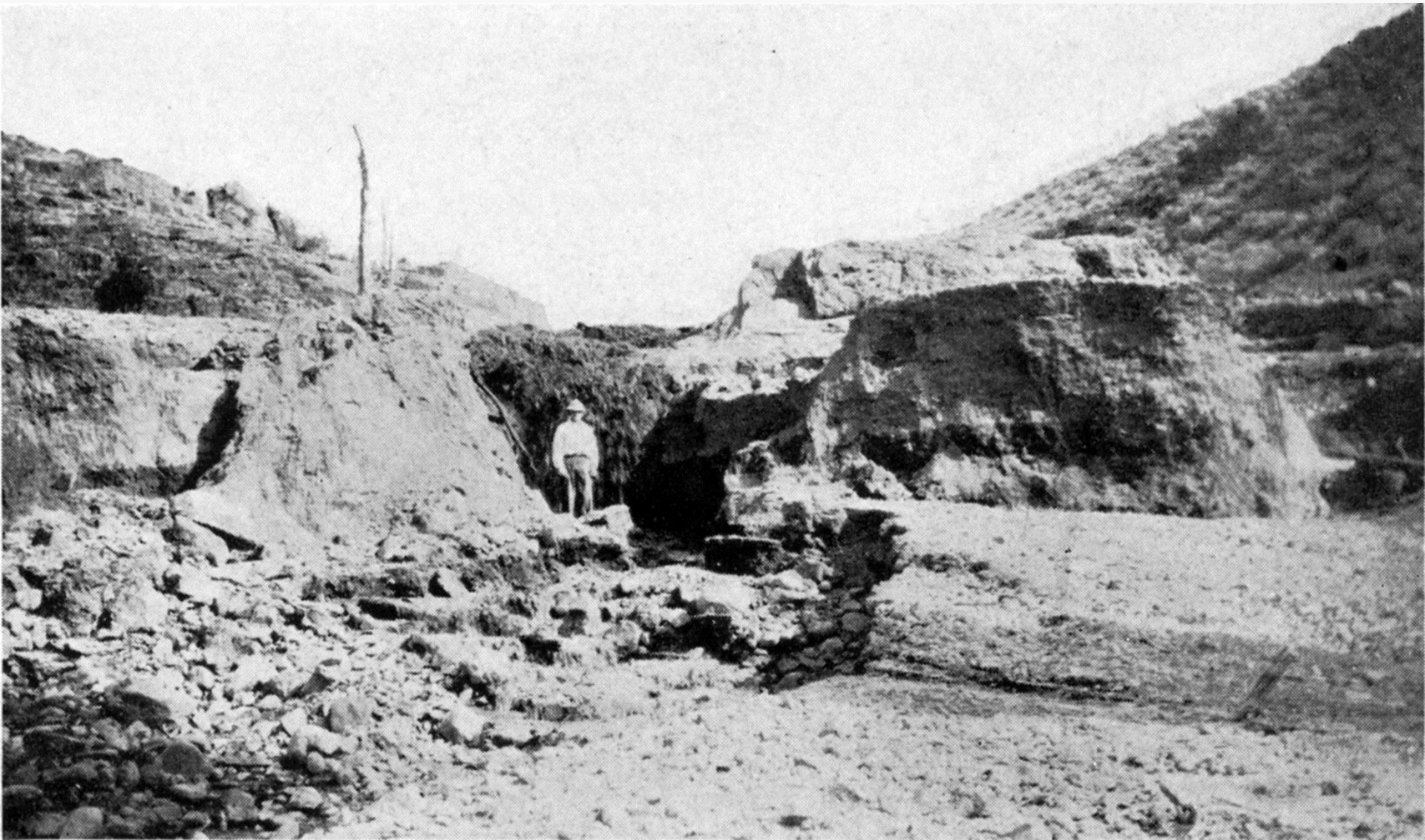
1915 Pleasant Valley Earthquake; M 7.3



Modified Mercalli
Intensity Map



Modified from Stover and
Coffman, 1993



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1915 Pleasant Valley M 7.3
Ground offset about 15 feet vertical
Created waterfall from new spring flow



Earthquake Collapsed SP Water Tank, Lovelock - 10-2-1915

1915 earthquake tank damage
Lovelock – 42 miles away from
earthquake



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NEVADA EARTHQUAKE BEHAVIOR

- × 88%-90% M 6 eqs. had foreshocks.
- × 22% M 6 eqs were **multiple events** w/in few mo.
- ×
- × 17% M 6 eqs were **multiple events** w/in **12 hrs.**



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RESPONSE OF PEOPLE TO EARTHQUAKES

- ✖ People ran outside of buildings fearing for their lives.
- ✖ People needed to talk to others immediately after, including calling 911;
- ✖ *“Check On Your Neighbors”*.
- ✖ Increases in people passing away and leaving town.



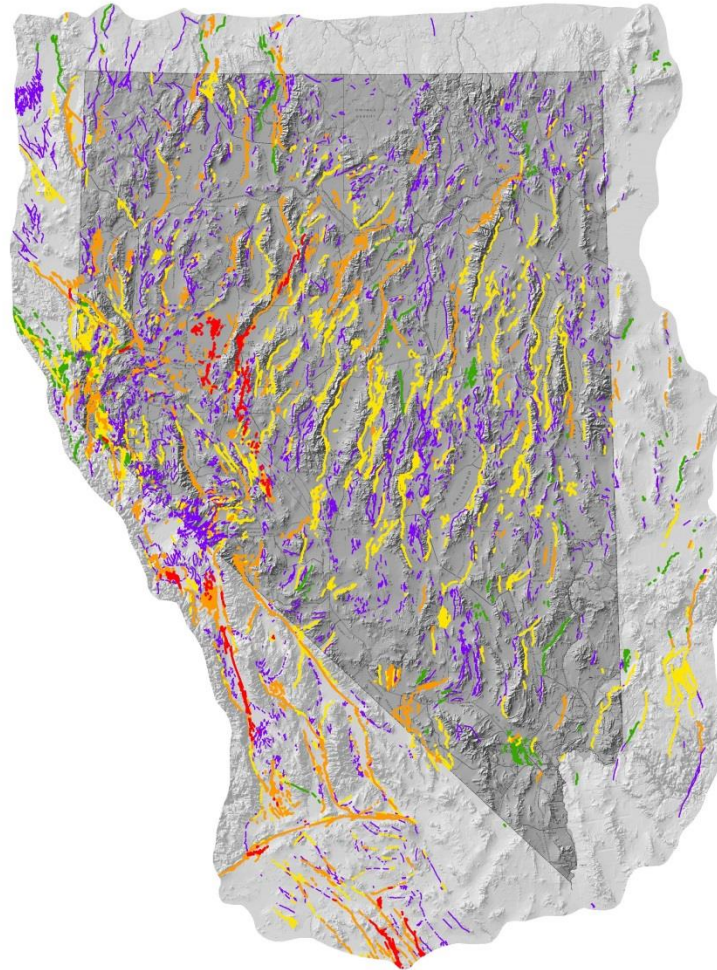
PROFESSIONAL RESPONSE TO EARTHQUAKES

- × Overall Excellent:
- × 1948 Reno Fire Chief
- × 1954 Fallon Police Officers
- × 2008 Wells Emergency Responders



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
EARTHQUAKE POTENTIAL IN NEVADA



>1500 possible
earthquake sources
across the state

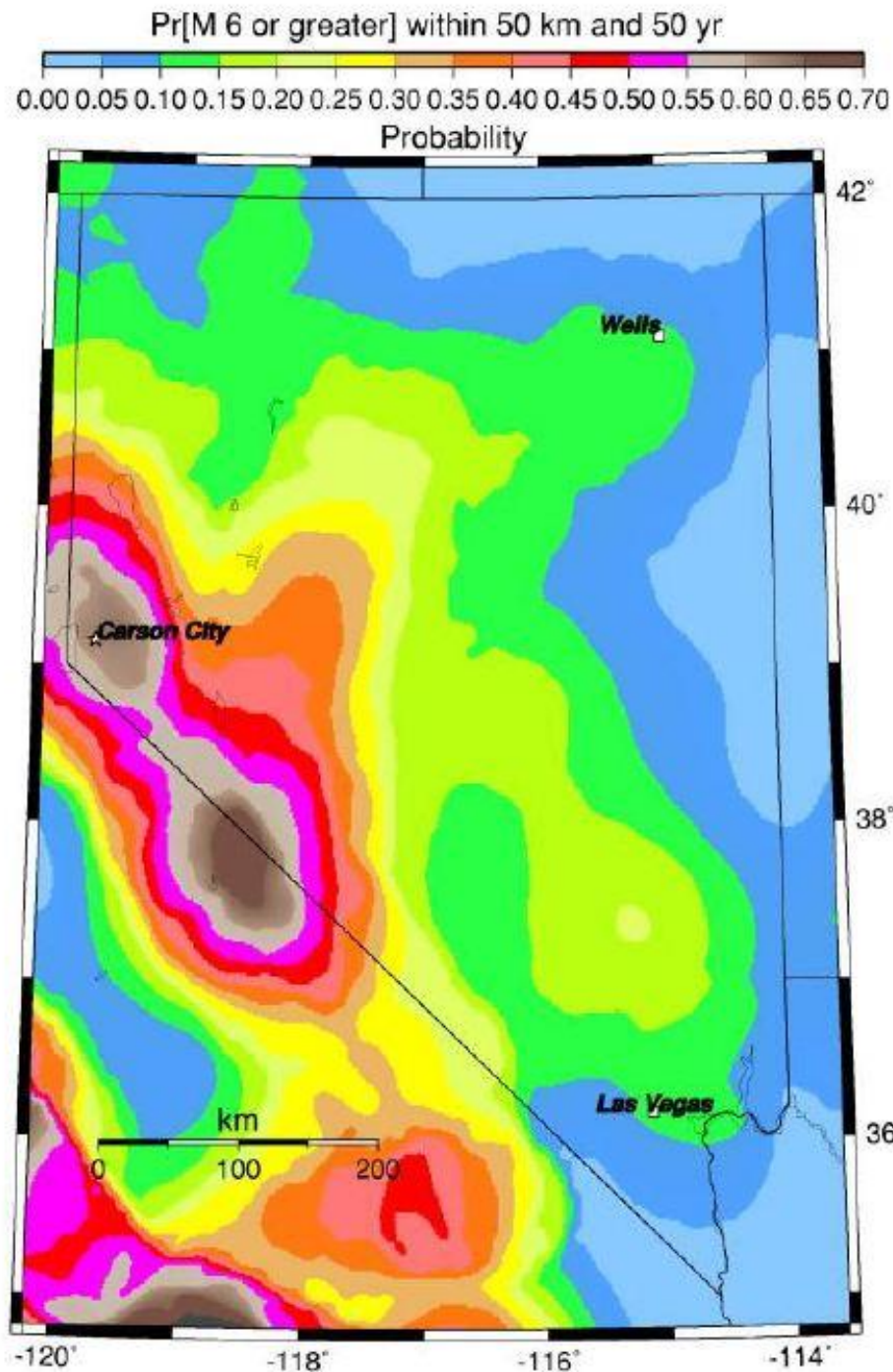
Many earthquake
sources throughout
Nevada

Years Before Present of Latest Fault Rupture

	<150	Historical
	<15,000	Latest Pleistocene and Holocene
	<130,000	Latest Quaternary
	<750,000	Mid-Quaternary
	<1,800,000	Quaternary



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**Wells 12% chance
M6 in 50 yrs**

**M6 earthquake
occurred
Feb. 21, 2008**



POTENTIAL CONSEQUENCES – COLLATERAL DAMAGE

- ✖ Instantaneous, widespread disaster w/o warning
- ✖ Multiple victim locations likely
- ✖ Multiple fires locations likely
- ✖ Multiple HAZMAT incidences likely
- ✖ Overwhelming number of injuries
- ✖ Limited resources initially
- ✖ Highly anxious public aggravated by aftershocks



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POTENTIAL CONSEQUENCES

- ✖ Dozens of deaths
- ✖ Hundreds of injuries; hospitals overwhelmed
- ✖ Losses of buildings, homes, infrastructure
- ✖ Loss of communication, power, water, sewer functions

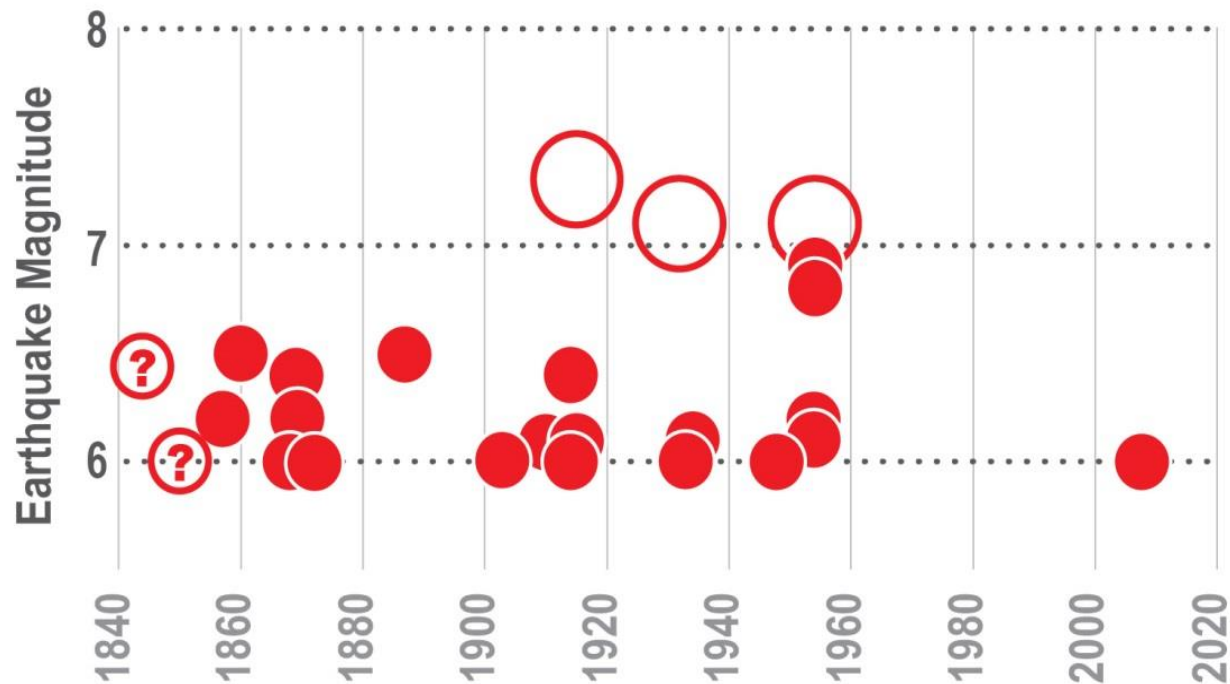


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POTENTIAL CONSEQUENCES \$\$\$

- ✖ Using **HAZUS** we project potential earthquake costs – real events have many unaccounted for effects and costs can range by an *order of magnitude* around projected amounts.
- ✖ A magnitude 6 near a Nevada community could create losses of **\$10.5+ million** as in Wells in 2008, to **\$1B** in Reno, to **\$3B** in Las Vegas.
- ✖ A magnitude 7 near Las Vegas creates the largest losses - **\$21B**.

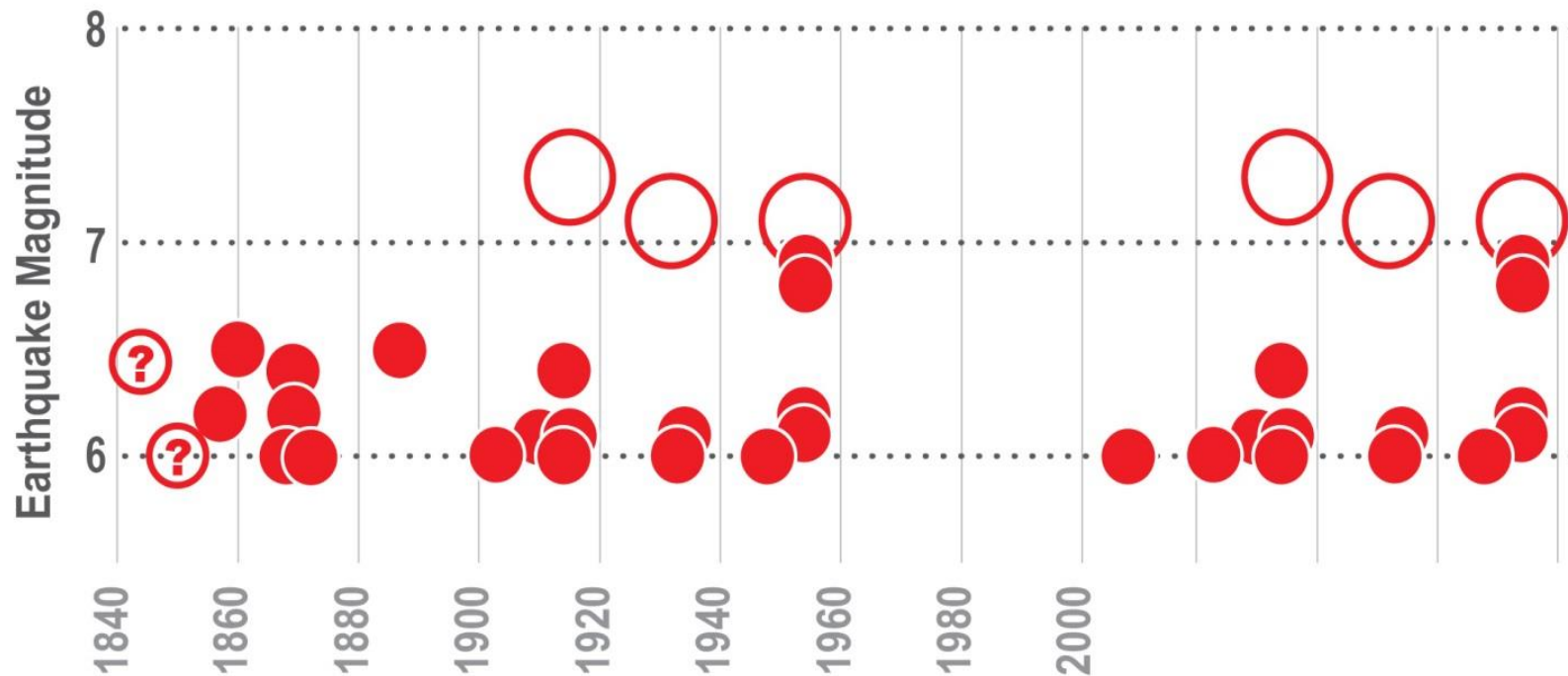




Nevada's Earthquake History



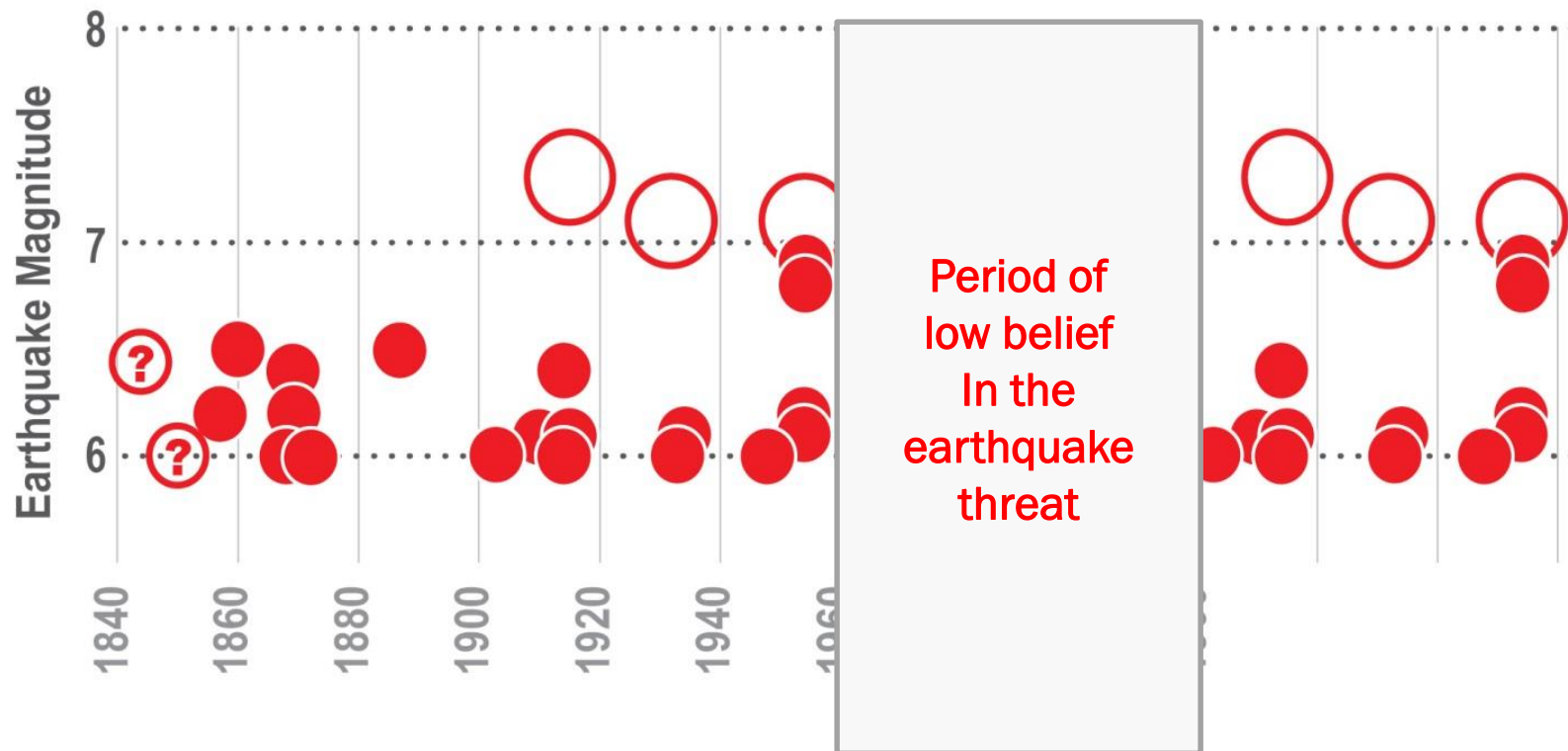
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Return to Nevada's Earthquakes



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NEVADA EARTHQUAKE PREPAREDNESS ASSERTION

- ✧ The vast majority of Nevadans are **not aware of the earthquake threat** in Nevada, **do not take earthquake safety to heart**, and **do not know how to react to** and mitigate to minimize earthquake losses.
- ✧ This has affected our state of earthquake preparedness and limited the amount of resources the state invests in earthquake threat characterization, preparedness, and response.



OPPORTUNITIES FOR INFLUENCING PEOPLE

- ✖ Windows of opportunity (earthquakes; Nevada ShakeOut)
- ✖ Social cueing (monkey see ...)
- ✖ Champions (leaders) of preparedness



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PROBLEM WITH RECENT LOWER RATE OF EARTHQUAKES

- ✧ Sparseness of recent damaging earthquakes affects how we think about and prioritize things like a THIRA, STAPLE+E, or relative risk – we **tend to underrate** earthquakes.
- ✧ Keep in mind – **earthquakes are about consequences**, not probabilities of occurrence.





THANK YOU



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POTENTIAL CONSEQUENCES

- × Acceptable versus Unacceptable Consequences

- × **Acceptable Consequences:**

- + Fear
- + Minor content damage
- + Cracks in wallboard



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POTENTIAL CONSEQUENCES

× Unacceptable Consequences:

- + Death due to negligence or inadequate response
- + Large numbers of injuries or deaths to select populations (e.g., lg loss of school children)
- + Large amounts of damage
- + Major life-changing losses to livelihood
- + Permanent loss of quality of life (poor recovery)



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