



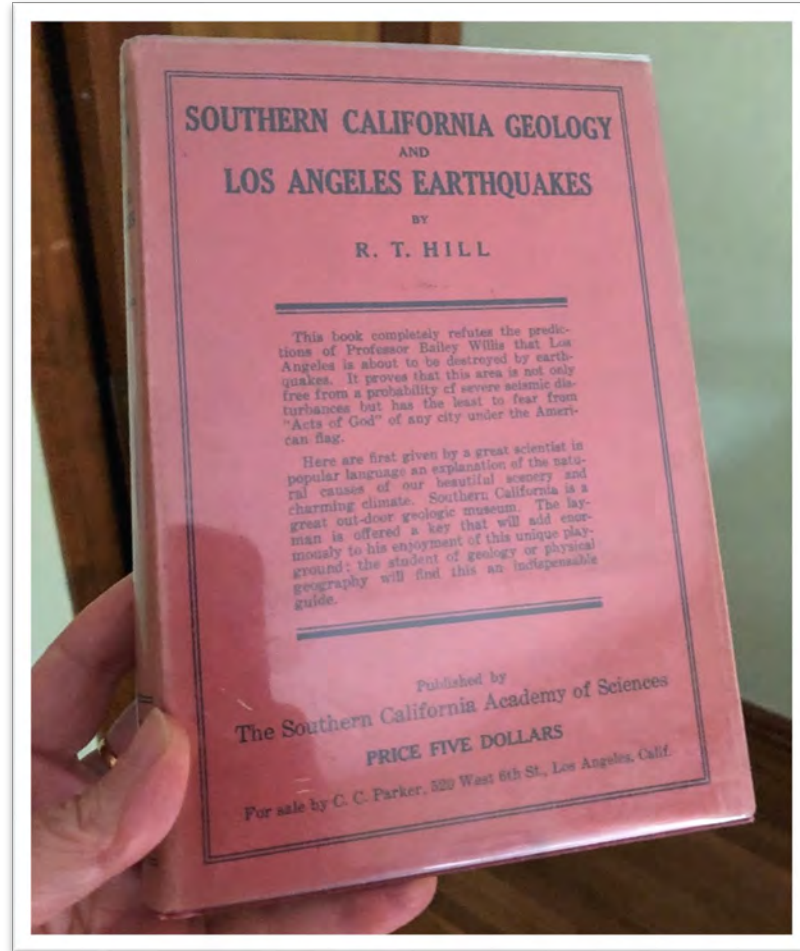
The 1925 M6.5 Santa Barbara Earthquake: A Pivotal Event

Susan E. Hough
USGS

Earthquake Chronology

- 1906 → Earthquake hazard in Bay Area
 - San Andreas fault mapped to San Geronimo Pass
 - 1916 → Hazard in Southern California/Los Angeles? (Wood)
 - Start of “earthquake exploration”
 - 1925 → Santa Barbara
 - Late 1925 → Willis prediction
 - 1928 → “Southern California Geology and Los Angeles Earthquakes”
 -
- Prediction debunked, fall-out, retrenchment...

[Los Angeles] has the least to fear from 'Acts of God' of any city under the American Flag



Natural Disaster *Deaths*

LOS ANGELES

- 1925 Santa Barbara earthquake – 13
- 1928 St. Francis dam collapse -- 430

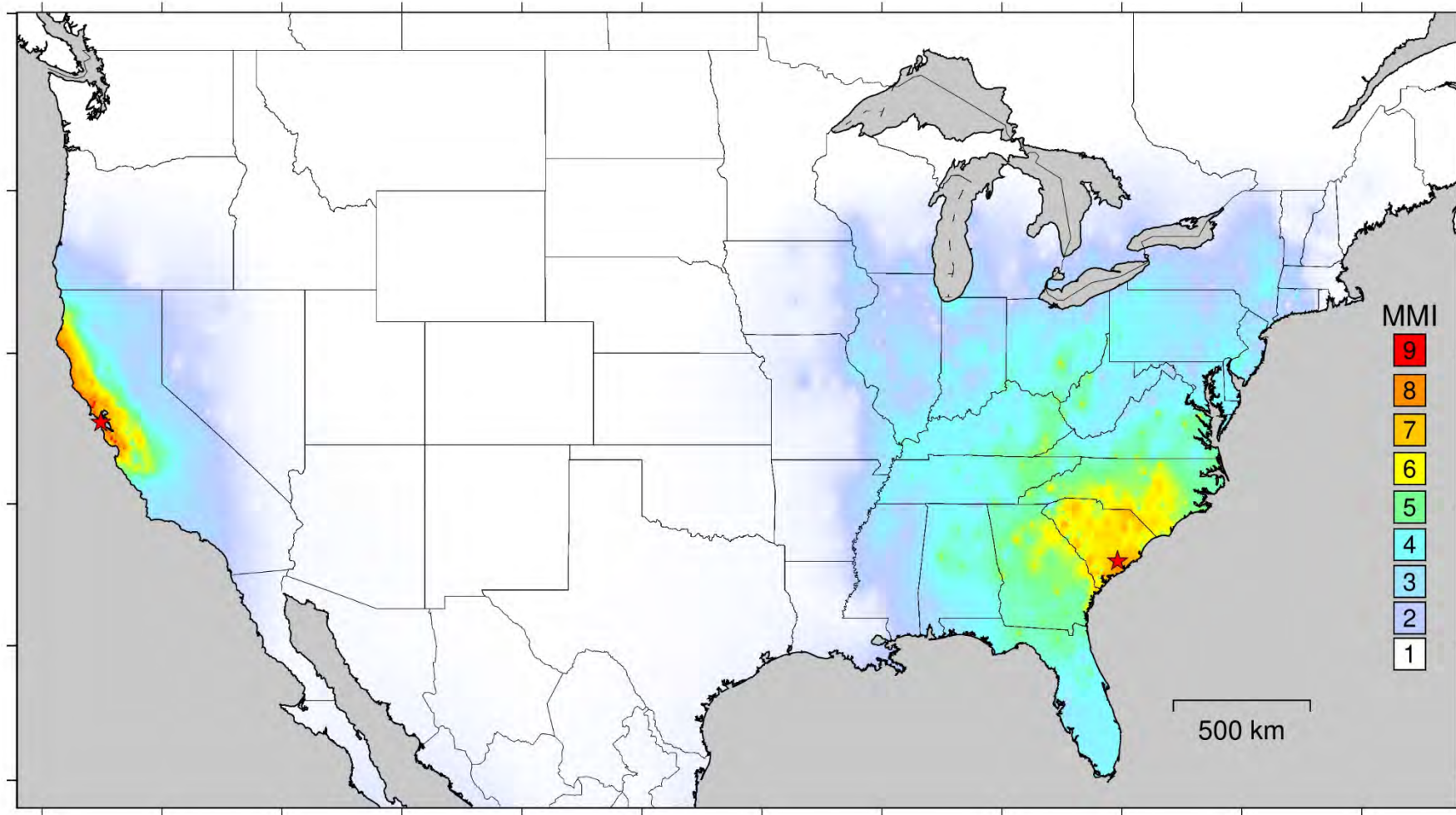
UNITED STATES

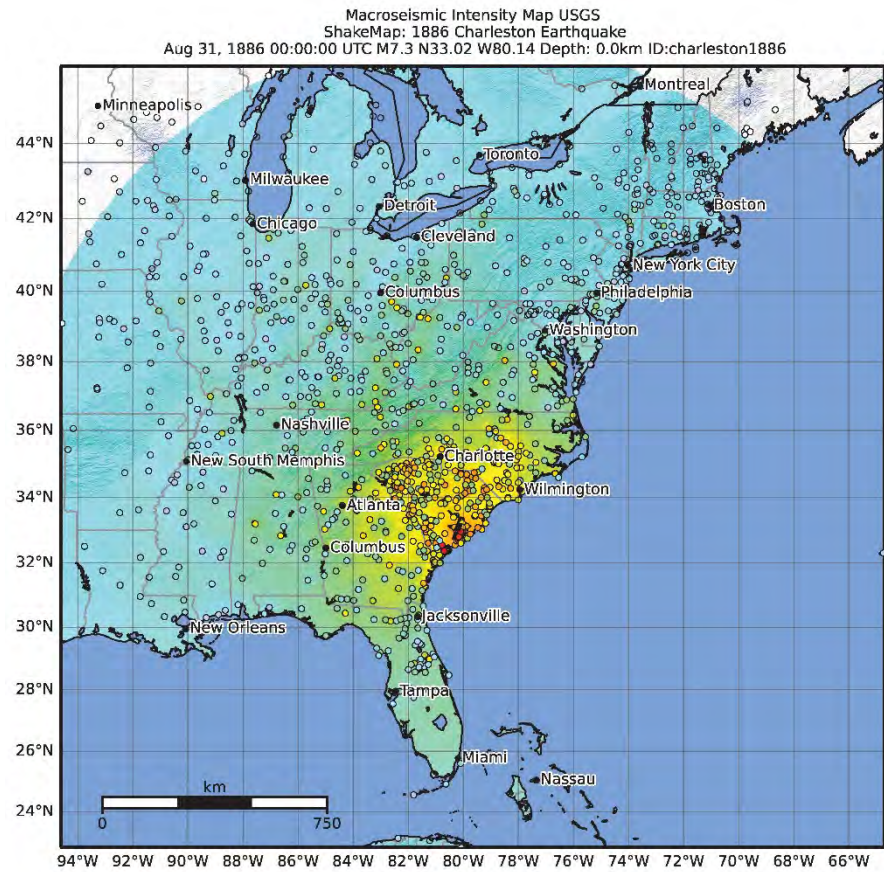
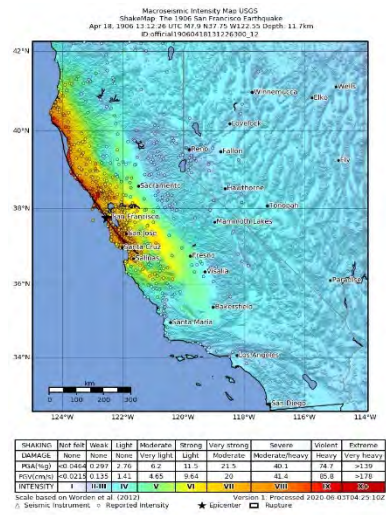
- 1900 Galveston, TX, storm – 6000(?)
- 1906 San Francisco **earthquake** – 1000
- 1889 Johnstown, PA, flood – 2200
- 1871 Peshtigo, MI, fire – 2500
- 1928 Okeechobee cyclone, FL – 2500+
- 1893 Hurricane, Louisiana – 1100+

“Seismic conditions are declining”

- Misperception
 - Faulting accommodates vertical motions
 - Plate tectonics → driving forces
- Insight
 - Vertical faulting less active now than in the past

Charleston (M7) vs San Francisco (7.9)





SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0066	0.0066-0.0095	0.0095-0.0154	0.0154-0.0249	0.0249-0.0398	0.0398-0.0629	0.0629-0.1	0.1-0.16	>0.16
PGV(cm/s)	<0.0028	0.0028-0.0043	0.0043-0.0068	0.0068-0.0107	0.0107-0.016	0.016-0.025	0.025-0.039	0.039-0.063	>0.063
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Walden et al. (2012)
Version 1: Processed 2023-07-24T21:08:41Z
Seismic Instruments Reported Intensity Epicenter Rupture

29 June 1925

The New York Times.

NEW YORK, TUESDAY, JUNE 30, 1925. TWO CENTS in Greater New York | THREE CENTS Within 100 Miles | FOUR CENTS Elsewhere in the U. S.

THE WEATHER
Fair today and tomorrow; northwest winds, becoming variable.
Temperature yesterday: Max. 51, min. 68.
For weather report see Page 25.

SUBWAYS FLOODED; HOMEBOUND CROWDS DRIVEN INTO STORM
Traffic Tied Up in Brooklyn, Cellars Filled and Buildings Damaged.
LIGHTNING STARTS FIRES
Fourth Avenue Line of B. M. T. Between 59th and 86th Sts. Blocked Four Hours.
BLINDED BY RAIN, RUN OVER
Man Killed on Bridge Plaza—Aerial Struck and Home Fired—Staten Island Building Burns.
A thunder and lightning storm of exceptional force but of short duration swept over the metropolitan district shortly after sundown yesterday, accompanied by a downpour of rain that flooded cellars and seriously interfered with transportation lines all over the city. In Brooklyn and other sections it reached the proportions of a cloudburst. About two hours earlier a thunderstorm broke over certain sections of the city, but the rain which fell then was soon carried off by the sewers, and little delay in traffic resulted. There was a third storm just as theatre audiences were pouring out of amusement places in all parts of the city.

SEVERE EARTHQUAKE WRECKS SANTA BARBARA; HOTELS COLLAPSE; BUSINESS AREA IS IN RUINS; 12 PERSONS KILLED; PROPERTY LOSS OF MILLIONS
MANY WEIRD EXPERIENCES
Buildings Buffeted Like Ships in Storm, Eyewitnesses Say.
CRUNCHING SOUNDS HEARD
Hotel's Walls Fall Away, Leaving Guests Lying Safely Aboard on All Floors.
TRAIN ROCKS LIKE CRADLE
Los Angeles Man Aboard Sees Trees Shaking, Houses Moving and People Running From Them.
SANTA BARBARA, June 29 (U.P.)—"I have been through fifty earthquakes, but never one like this before," said Manager Richmond of the Arlington Hotel. "It just took the hotel that we

HÔTEL RIPPED AND TORN BY EARTHQUAKE.
The Arlington at Santa Barbara That Felt Full Force of the Shock and Where Two Lives Were Lost.

WASHINGTON OFFERS EARTHQUAKE RELIEF
Red Cross Appropriates Funds, Army and Navy Are Held.
President Promptly Orders All Possible Aid Given.
Special to The New York Times.
PLYMOUTH, N.Y., June 29.—President Coolidge this afternoon sent the following telegram to the Acting Secretary of War:
"You and Secretary of Navy give

EXPERTS DIVIDED ON CAUSE OF SHOCKS
Ocean Leakage, Snapping of Earth's Crust and Other

TREMORS CONTINUE ALL DAY
Second Big Shock in Early Morning Causes Most Damage to City.
BURST DAM BRINGS FLOOD
Principal Buildings Are Razed or Damaged, Including Famous Spanish Mission.
COMPLETE ORDER PREVAILS
Citizens Start Plans for Reconstruction, Mayor Declaring Outside Aid Is Not Needed.
Special to The New York Times.
SANTA BARBARA, Cal., June 29.—A series of severe earthquakes, starting at 6:42 o'clock this morning, wrecked all the principal buildings in Santa Bar-

29 June 1925

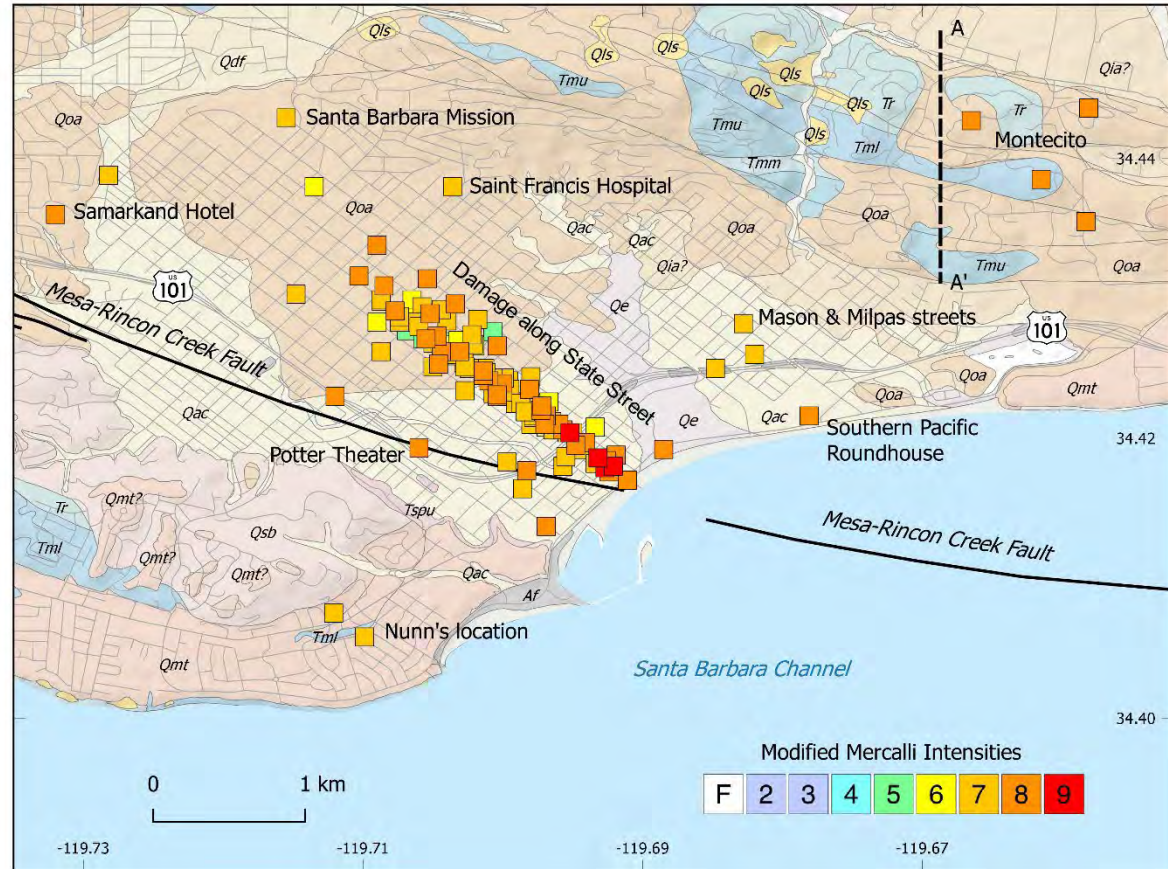


29 June 1925

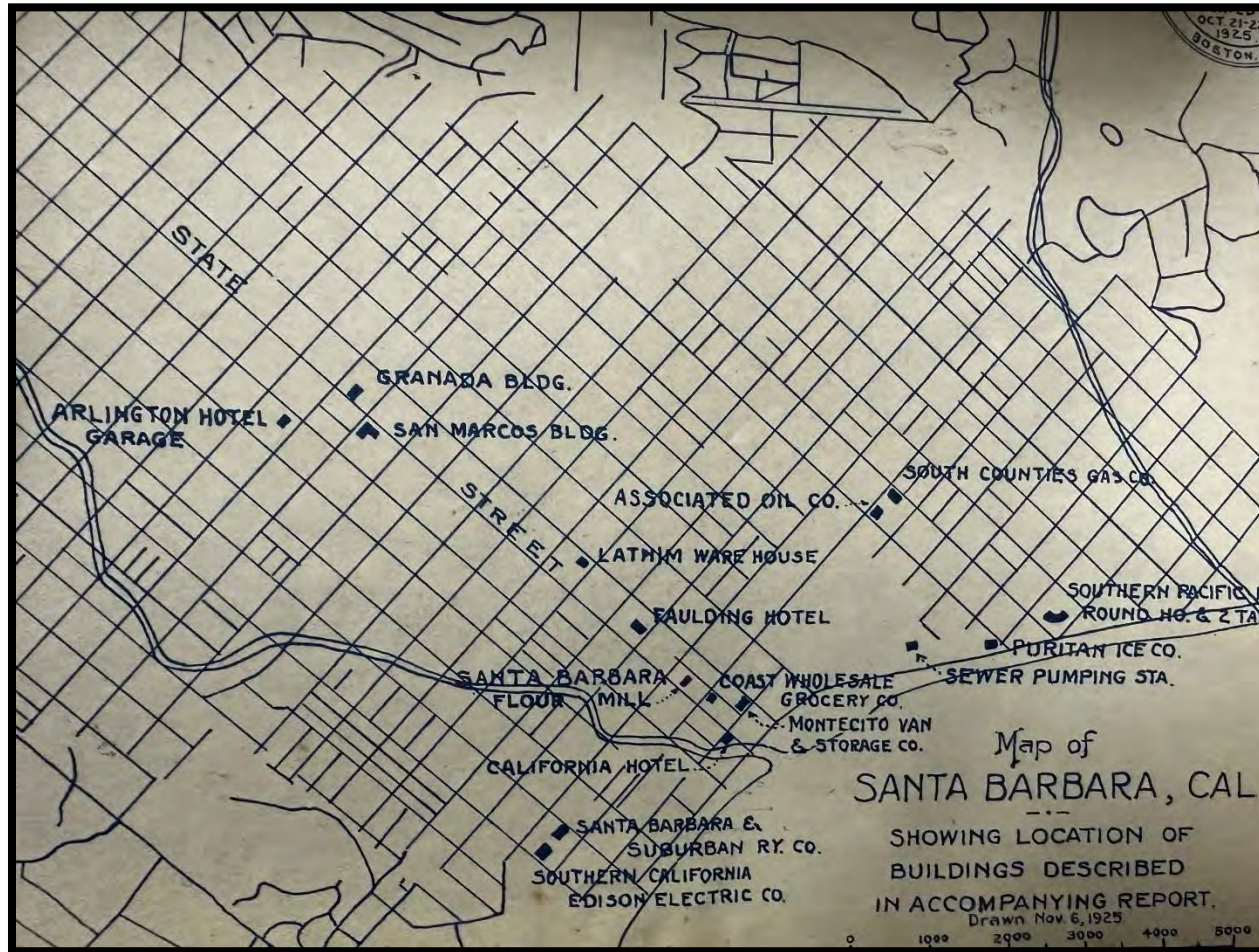


Data

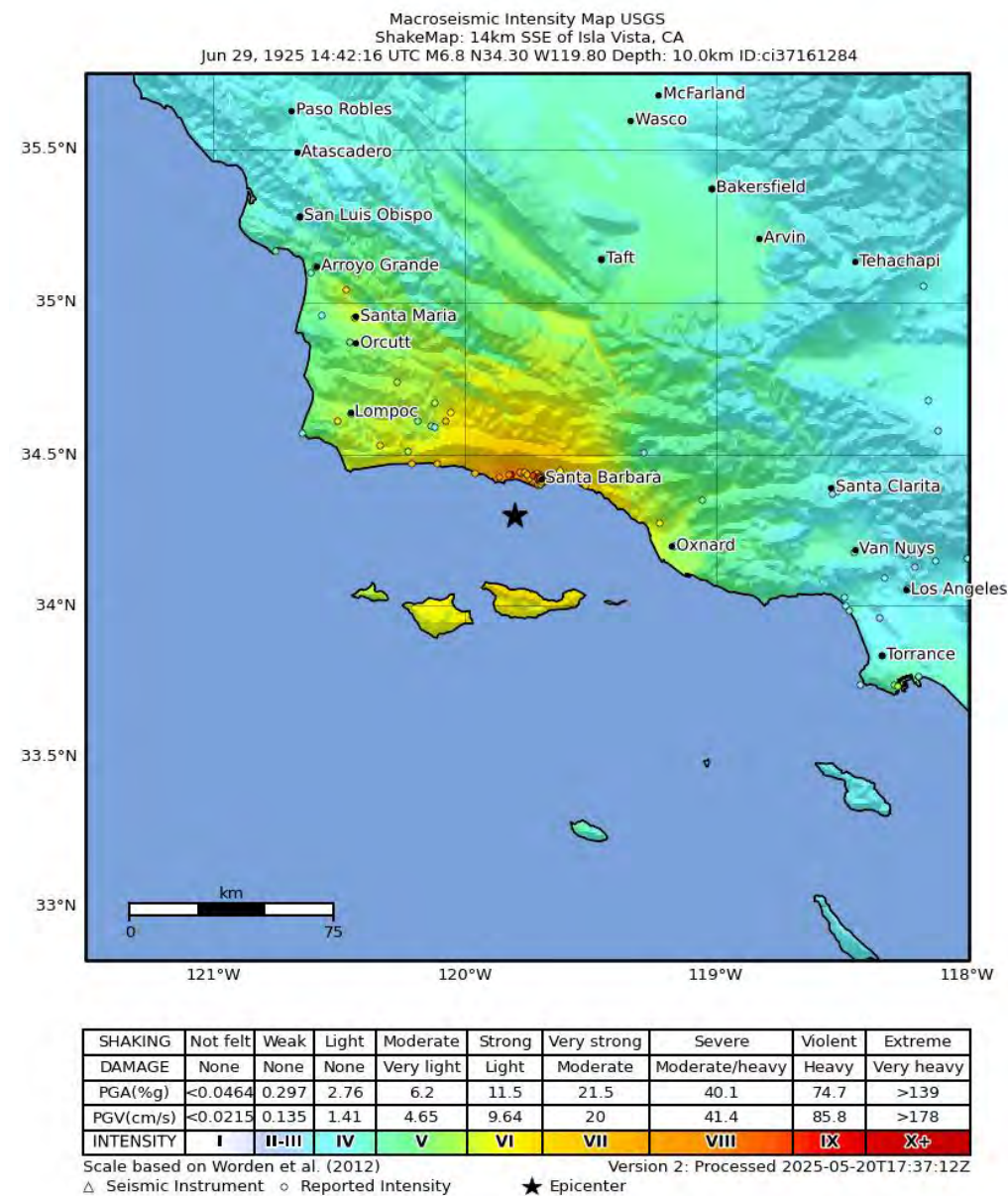
- **Macroseismic**
 - Newspapers
 - Photographs
 - Engineering reports
- Network bulletin
- Waveform



Damage



ShakeMap



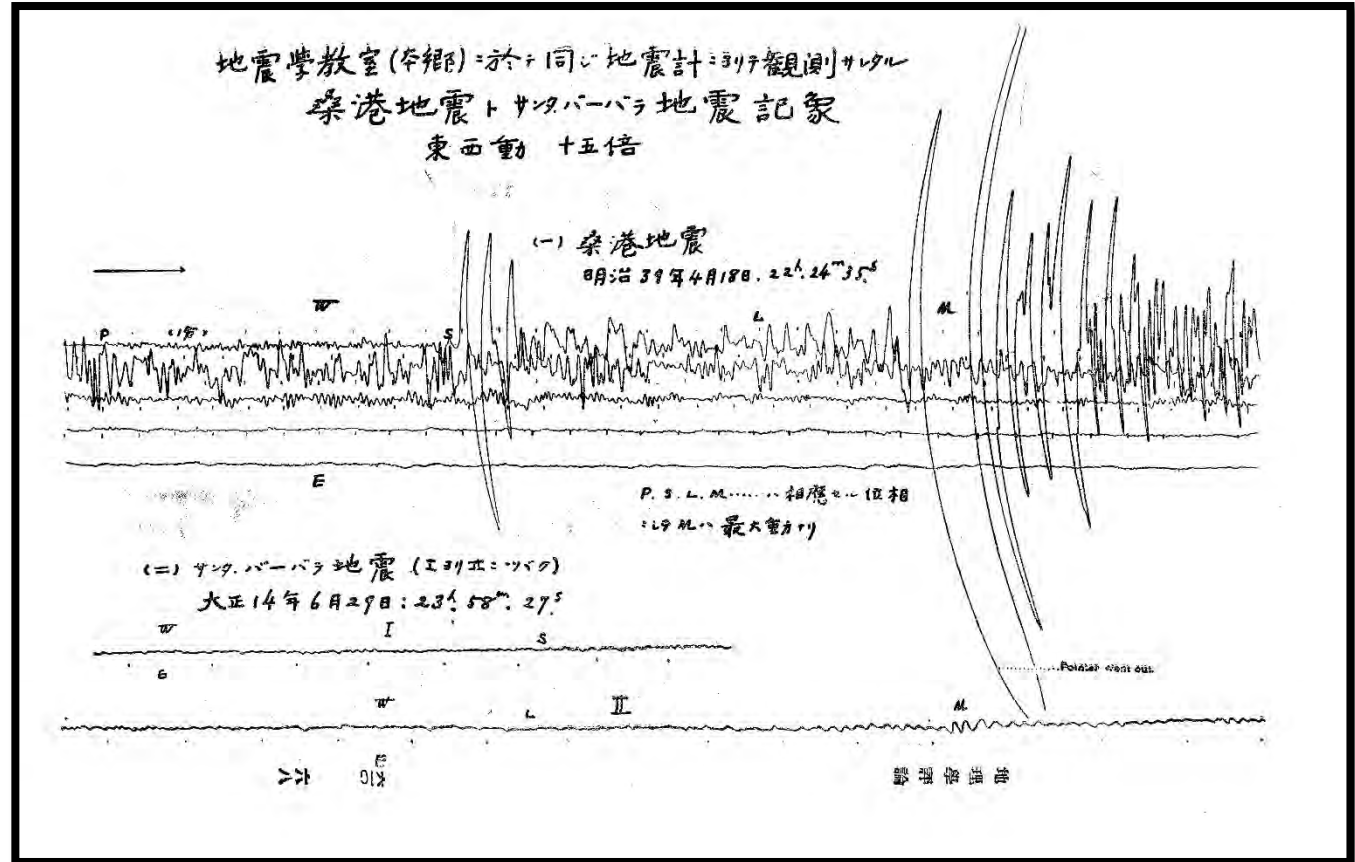
Data

- Macroseismic
 - Newspapers
 - Photographs
 - Engineering reports
- Network bulletin
- Waveform

#	Station	Code	Comp	Er	Latitude degrees	Longitude degrees	τ sec	1/2 A μ	Δ degrees
1	Lick	MHC	E		37.341	-121.642	19.00	405.00	3.37
2	Lick	MHC	N		37.341	-121.642	14.00	312.00	3.37
3	Lick	MHC	Z		37.341	-121.642	7.00	597.00	3.37
4	Santa Clara	SLC	E		37.354	-121.955	1.50	420.00	3.51
5	Santa Clara	SLC	N		37.354	-121.955	1.50	520.00	3.51
6	Berkeley	BRK	E	-0.15	37.871	-122.272	10.00	670.00	4.08
7	Berkeley	BRK	N	-0.15	37.871	-122.272	9.00	905.00	4.08
8	Berkeley	BRK	Z	-0.15	37.871	-122.272	9.00	1570.00	4.08
9	Tucson	TUO	E		32.221	-110.926	11.00	78.00	7.59
10	Victoria	VIC	E	-0.01	48.415	-123.330	12.00	207.00	14.30
11	Victoria	VIC	Z	-0.01	48.415	-123.330	12.00	15.00	14.30
12	Mazatlan	MAZ	NS		23.249	-106.411	10.00	21.00	16.07
13	Mazatlan	MAZ	EW		23.249	-106.411	8.00	25.00	16.07
14	Tacubaya	TAC	NS		19.339	-99.180	7.00	52.00	23.60
15	Tacubaya	TAC	NS		19.339	-99.180	6.00	74.00	23.60
16	Tacubaya	TAC	Z		19.339	-99.180	8.00	104.00	23.60
17	Saint Louis	SLM	E		30.672	-90.199	14.00	28.00	25.03
18	Saint Louis	SLM	N		30.672	-90.199	20.00	26.00	25.03
19	Sitka	SIT	E		57.053	-135.330	13.00	5.00	25.07
20	Sitka	SIT	N		57.053	-135.330	12.00	5.00	25.07
21	New Orleans	NOL	E		29.951	-90.071	7.00	80.00	25.35
22	New Orleans	NOL	N		29.951	-90.071	7.00	65.00	25.35
23	Veracruz	VON			19.260	-96.578	9.00	103.00	25.47
24	Toronto	TRT	E	0.2	43.653	-79.383	10.00	104.00	32.29
25	Toronto	TRT	N	0.2	43.653	-79.383	15.00	173.00	32.29
26	Toronto	TRT	Z	0.2	43.653	-79.383	5.00	69.00	32.29
27	Georgetown	GEO	E		38.907	-77.036	6.00	11800.00	34.20
28	Georgetown	GEO	N		38.907	-77.036	6.00	4200.00	34.20
29	Ithaca	ITH	N		42.444	-76.501	11.00	30.00	34.39
30	Ottawa	OTT	-n/a-	0.13	45.409	-75.704	17.00	193.00	35.00
31	Ottawa	OTT	-n/a-	0.13	45.409	-75.704	12.00	80.00	35.00
32	Cheltenham	CLM	E		34.734	-76.827	11.00	9.00	35.02
33	Cheltenham	CLM	N		34.734	-76.827	9.00	15.00	35.02
34	Honolulu	HON	E		21.309	-157.850	10.00	119.00	36.06
35	Honolulu	HON	N		21.309	-157.850	10.00	245.00	36.06
36	Cambridge	CAM	E		42.373	-71.109	13.00	125.00	38.37
37	Cambridge	CAM	N		42.373	-71.109	13.00	350.00	38.37
38	Uppsala	UPP	E	0.08	59.859	17.639	14.00	6.00	79.51
39	Uppsala	UPP	N	0.08	59.859	17.639	17.00	10.00	79.51
40	De Bilt	DBN	E	-0.24	52.109	5.181	19.00	54.00	81.12
41	De Bilt	DBN	N	-0.24	52.109	5.181	29.00	26.00	81.12
42	De Bilt	DBN	Z	-0.24	52.109	5.181	32.00	16.00	81.12
43	Paris	PAR	E	0.06	48.856	2.352	21.00	13.00	82.20
44	Paris	PAR	N	0.06	48.856	2.352	25.00	17.00	82.20
45	Pulkowa	PUL	-n/a-	0.06	59.802	30.267	17.00	14.00	82.70
46	Pulkowa	PUL	-n/a-	0.06	59.802	30.267	17.00	23.00	82.70
47	Pulkowa	PUL	-n/a-	0.06	59.802	30.267	18.00	14.00	82.70
48	Pulkowa	PUL	-n/a-	0.06	59.802	30.267	21.00	17.00	82.70
49	Pulkowa	PUL	-n/a-	0.06	59.802	30.267	22.00	16.00	82.70
50	Strasbourg	STR	E	-0.12	48.573	7.752	14.00	17.00	84.84

Data

- Macroseismic
 - Newspapers
 - Photographs
 - Engineering reports
- Network bulletin
 - **Waveform**
 - **Chen Ji poster!**

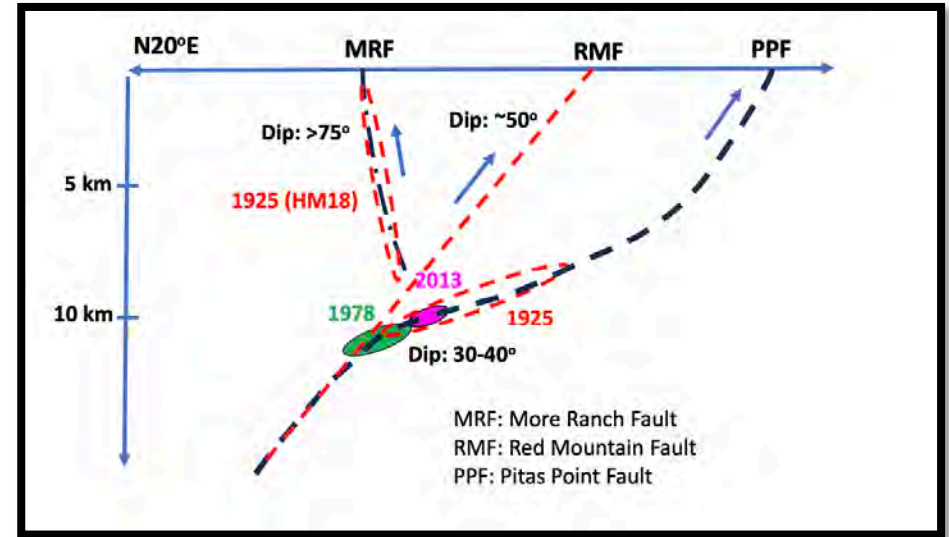
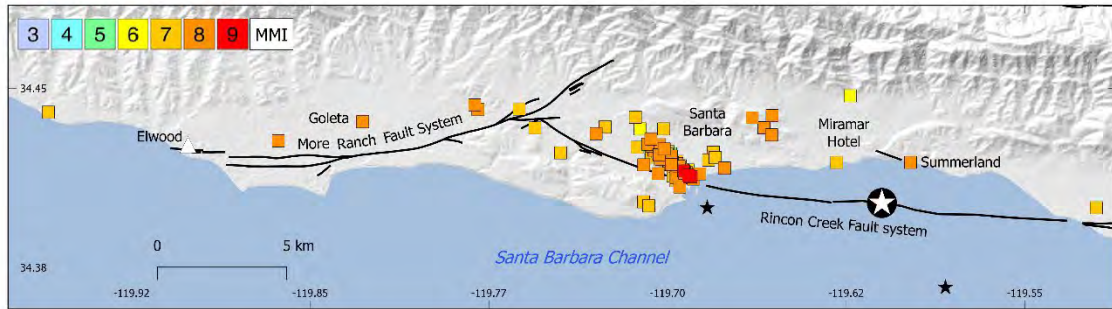


1906: ~1 cm

1925: ~0.1 mm → $M_s = 6?$

Source Model

- Hough and Martin (2018): M6.5, Rincon Creek-More Ranch
- Pitas Point

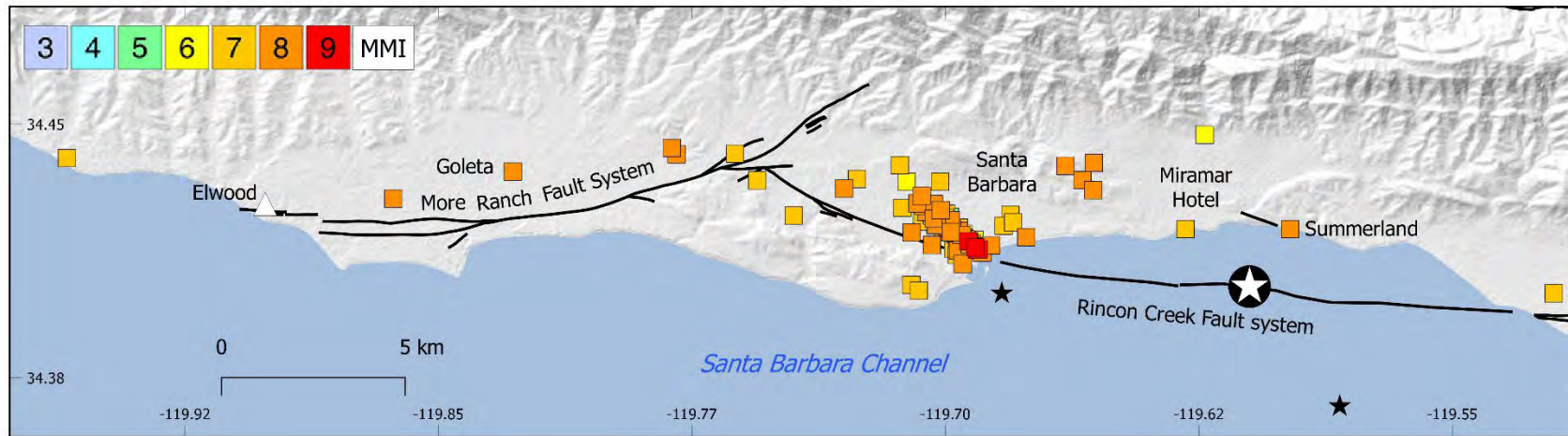


Macroseismic evidence

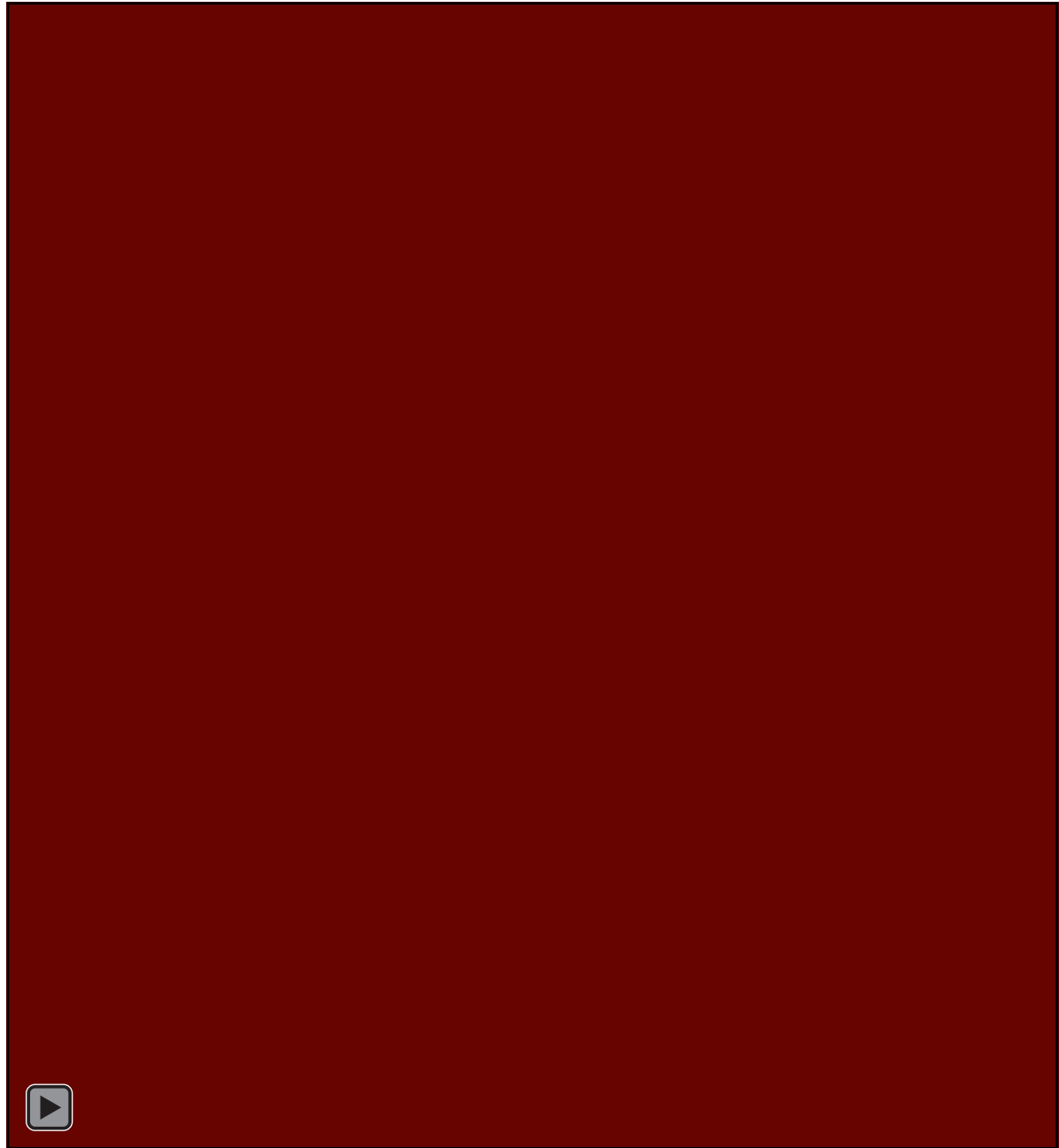
- Directionality of sound (Willis)
- Westward directivity
- Santa Barbara damage near coast, EW distribution
- Goleta report
- “Fissures”

Epicenter

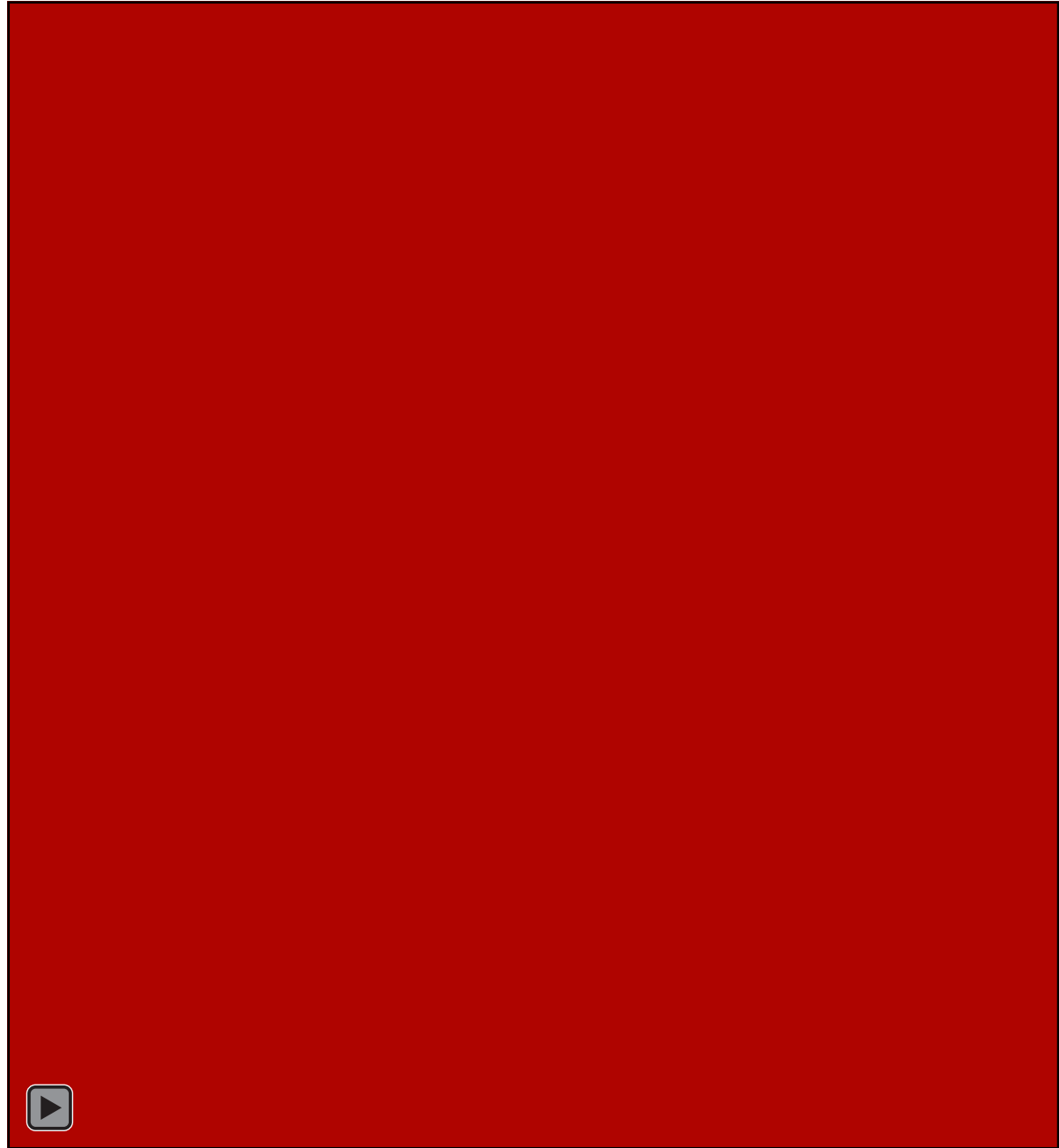
- Richter (1958): Ellwood Oil field (concentration of aftershocks)
- Hough and Martin (2018): Summerland (earwitness report)
- Intensity distribution: westward directivity



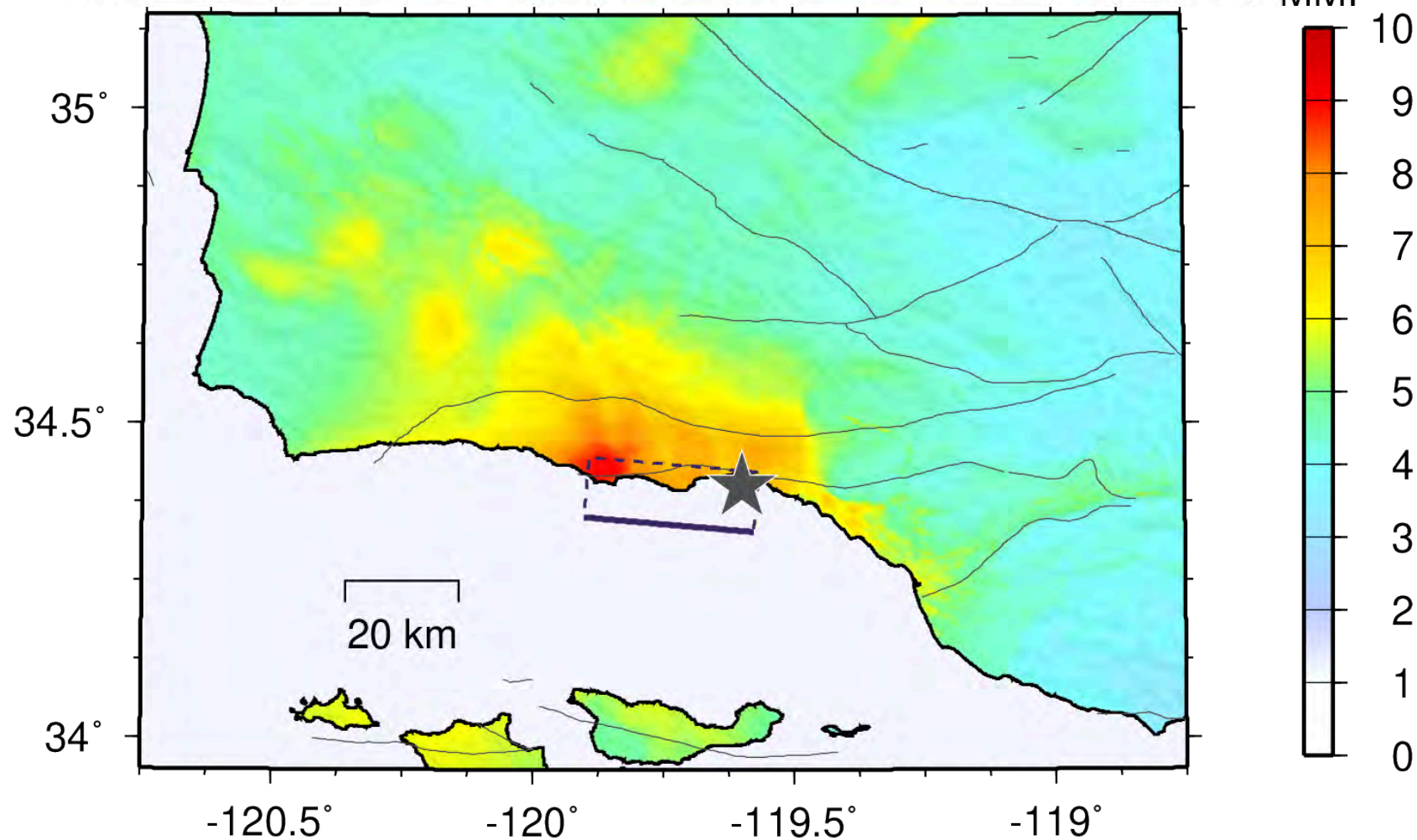
ShakeMovie 1 (Graves)



ShakeMovie 2 (Graves)



M6.6 (ff4) Santa Barbara, CA Simulated Intensity_{MMI}

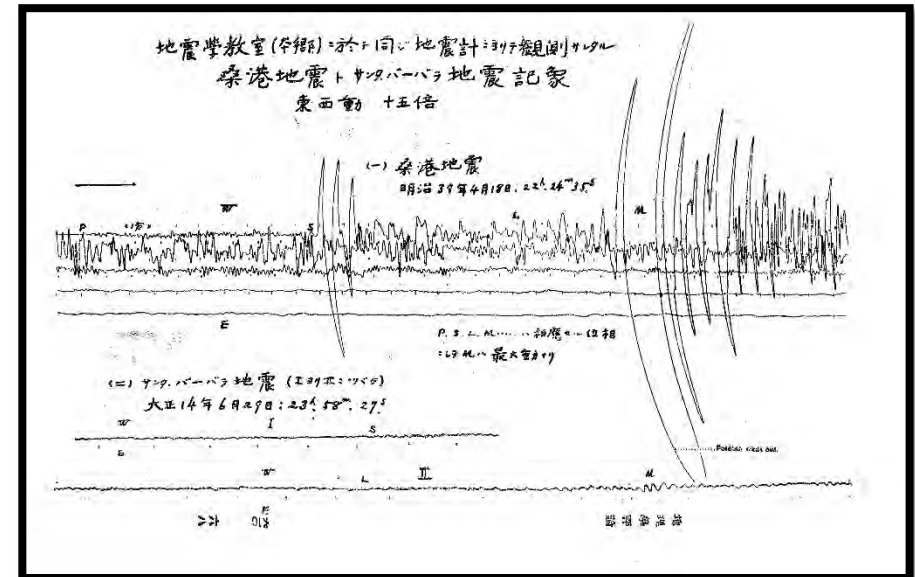


Ground “fissures”



Rupture Model

- M6.5-6.6 (macroseismic, bulletin data, waveform data)
- Westward directivity (macroseismic data, aftershocks)
- Pitas Point (lack of surface rupture, Japan = nodal?)
- Multi-fault or triggered slip



Rupture model

- A) Pitas Point (north-dipping)
- B) Steeply south-dipping
- C) Multifault rupture

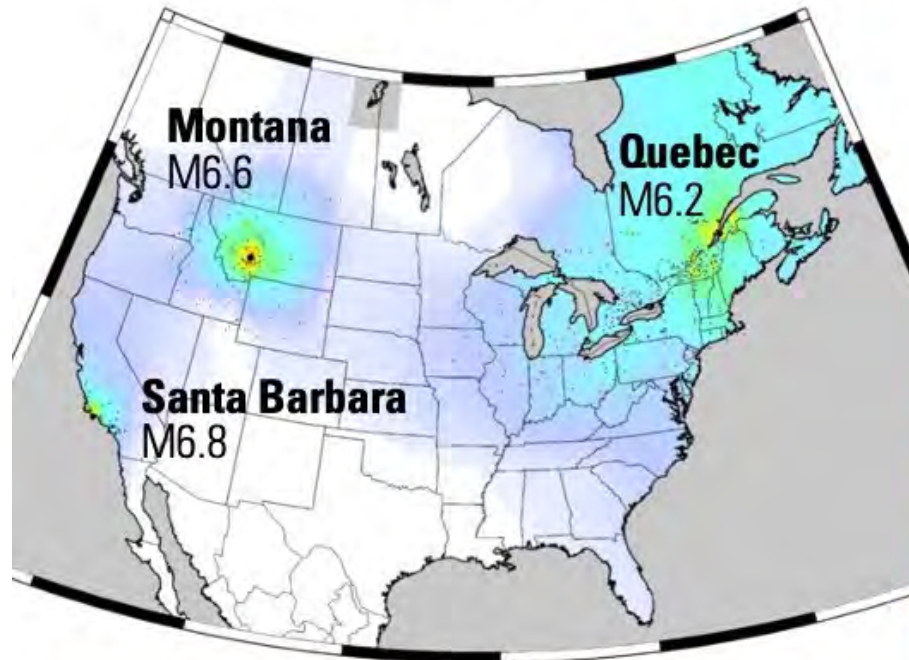
Impact

- Scientific investigations?
- Societal impact
 - Local building codes: Palo Alto, Santa Barbara (bldg height)
 - Urban planning: Santa Barbara
 - Int'l conference of building officials (formed 1922)→ UBC (1927)
 - Earthquake-resistant design
 - Impetus for regional monitoring network (Carnegie; 1927)
 - Willis prediction
 - Hill (1928)
 - 1933: Riley act, lateral forces

Public
perception?



A Trio of Large Earthquakes in 1925



Intensity	Shaking
I	Not felt
II	Weak
III	Weak
IV	Light
V	Moderate
VI	Strong
VII	Very strong
VIII	Severe
IX	Violent
X	Extreme



Settling the Score



Thank you!

