

CALIFORNIA
UNDERDUE – DUE – OVERDUE?

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Common Assumptions

- Magnitudes are limited by mapped fault length. Already disproven
- Segment boundaries exert control over large earthquake ruptures.
- Important faults are known and mapped.

- *Big quakes occur primarily on big faults.*
- *Sediment offsets in paleo-seismic trenches are caused only by quakes.*
- *Quakes repeat, with some variability, on a quasi-periodic schedule.*
- *“Characteristic” repeating quakes dominate moment rate and hazard.*

- Seismic moment rate equals tectonic moment rate over time.
- Earthquake and strain rates are effectively stationary.
Lithosphere is elastic.
- Quakes are started and controlled by stress.
- Big and small quakes come from same population.
- Rupture length, width, and slip scale with Moment.

The Current Unlikely Earthquake Hiatus at California's Transform Boundary Paleoseismic Sites

by Glenn P. Biasi and Katherine M. Scharer

Seismological Research Letters Volume 90, Number 3 May/June 2019

CONCLUSIONS

...If current statistical models of recurrence do apply and the current state is a statistical fluke, the averages would require an episode of heightened activity. If our models of recurrence must be amended, it is not clear how, or what mechanism(s) to include. Alternatively, we can hope that the future is unlike the record over the last 1000 yr.

DDJ Comments:

1. Paleo hiatus corresponds with good instrumental seismic observations not available at paleoseismic event times.
2. New Zealand had similar hiatus during last century
3. Number of recorded California earthquakes in last century is consistent with observed seismic shaking events in previous century

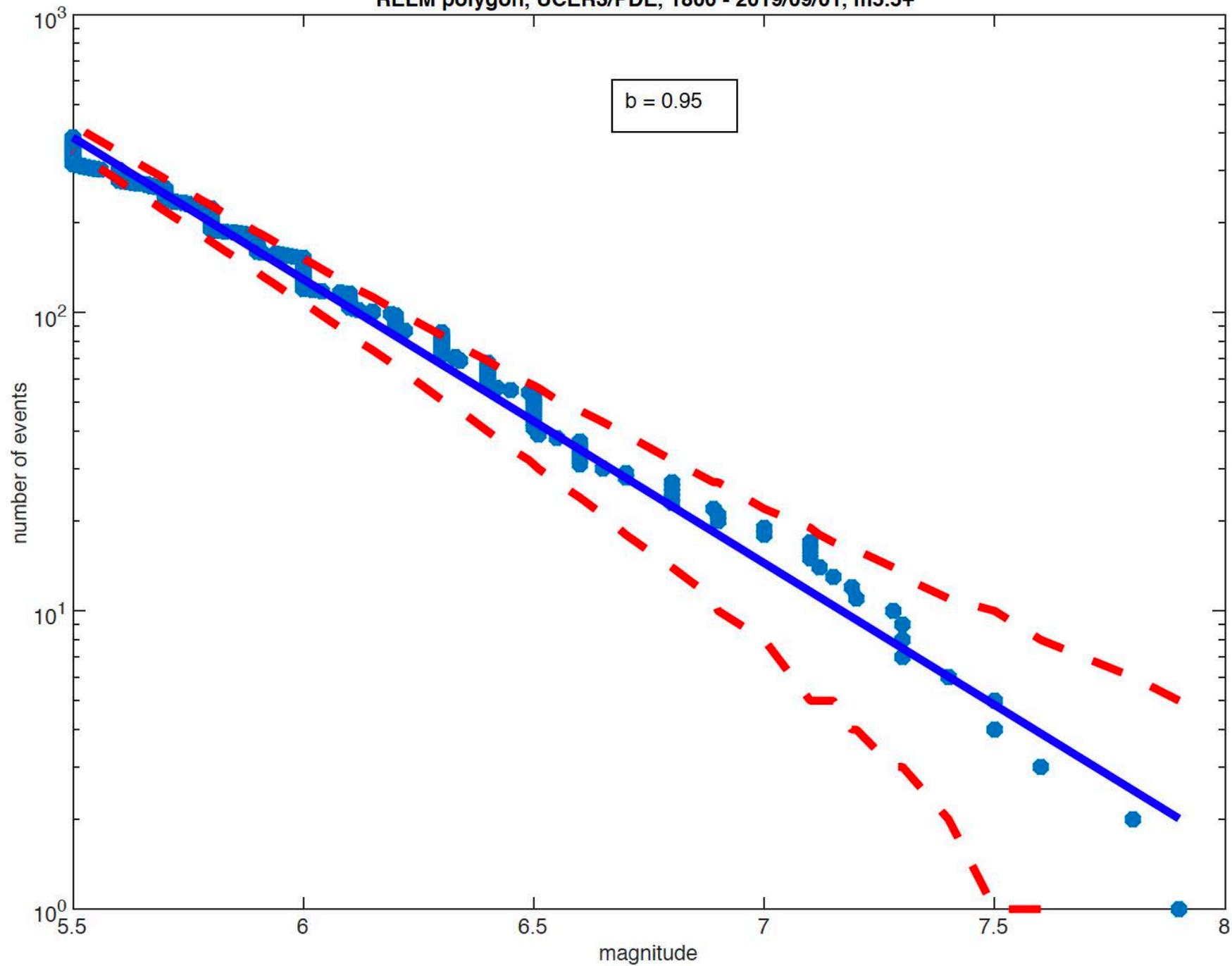
Data Selection

- Chose relevant, high-quality data without section bias
- Kagan-Console Rule: define terms and write selection rules early. After looking at the data, **it's too late to make unbiased statistical judgments.**
- I confess; can't strictly comply.

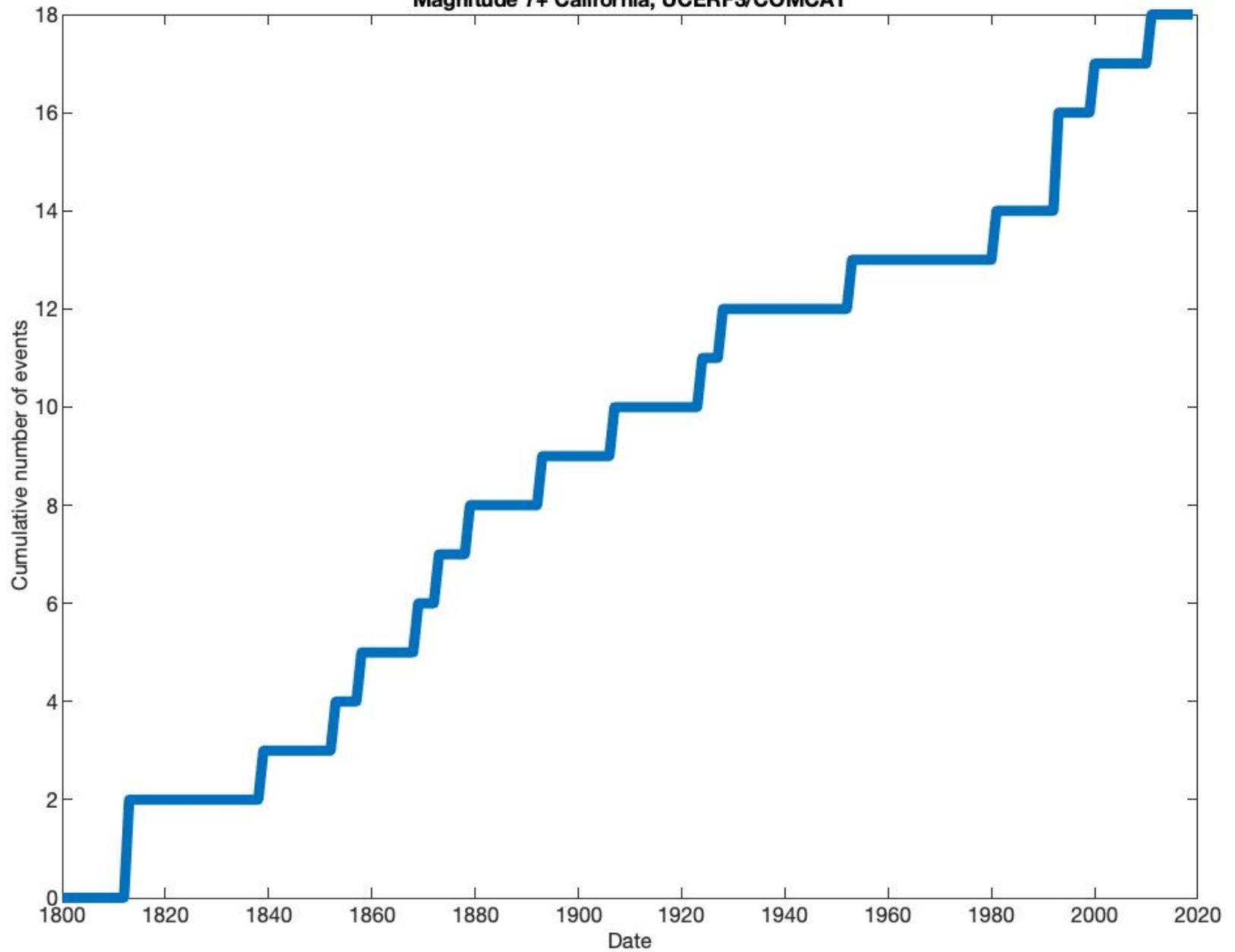
Relevant data

- Fault displacements, including paleo
- Observed shaking and damage
- Instrumentally observed seismic waves
- I combined UCERF3 Catalog (1759 – 2012) with COMCAT (2013 – 2019/09/01)

RELM polygon, UCER3/PDE, 1800 - 2019/09/01, m5.5+



Magnitude 7+ California, UCERF3/COMCAT



N2	P, cum	Interp
0	0.000	Overdue
1	0.000	Overdue
2	0.001	Overdue
3	0.007	Overdue
4	0.026	Overdue
5	0.073	Due
6	0.164	Due
7	0.305	Due
8	0.481	Due
9	0.659	Due
10	0.807	Due
11	0.908	Due
12	0.963	Underdue
13	0.988	Underdue
14	0.997	Underdue
15	0.999	Underdue
16	1.000	Underdue
17	1.000	Underdue
18	1.000	Underdue
19	1.000	Underdue

UCERF3/PDF, M7+, RELM POLYGON

1800 – 1920: $p_1 = 0.546$, $N_1 = 10$ events

1920 – 2020: $p_2 = 0.454$, $N_2 = 9$ events

Table shows cumulative binomial probability of given number of events, out of 19 total, landing in the last century. $N_2 = 9$ events is well within the expected range. Based on the catalog, we are

NOT OVERDUE

for m_7+ earthquakes

Evidence for Seven Surface Ruptures in the Past 1600 Years on the Claremont Fault at Mystic Lake, Northern San Jacinto Fault Zone, California

by Nathan W. Onderdonk, Thomas K. Rockwell, Sally F. McGill, and Gayatri I. Marliyani

Bulletin of the Seismological Society of America, Vol. 103, No. 1, pp. 519–541, February 2013

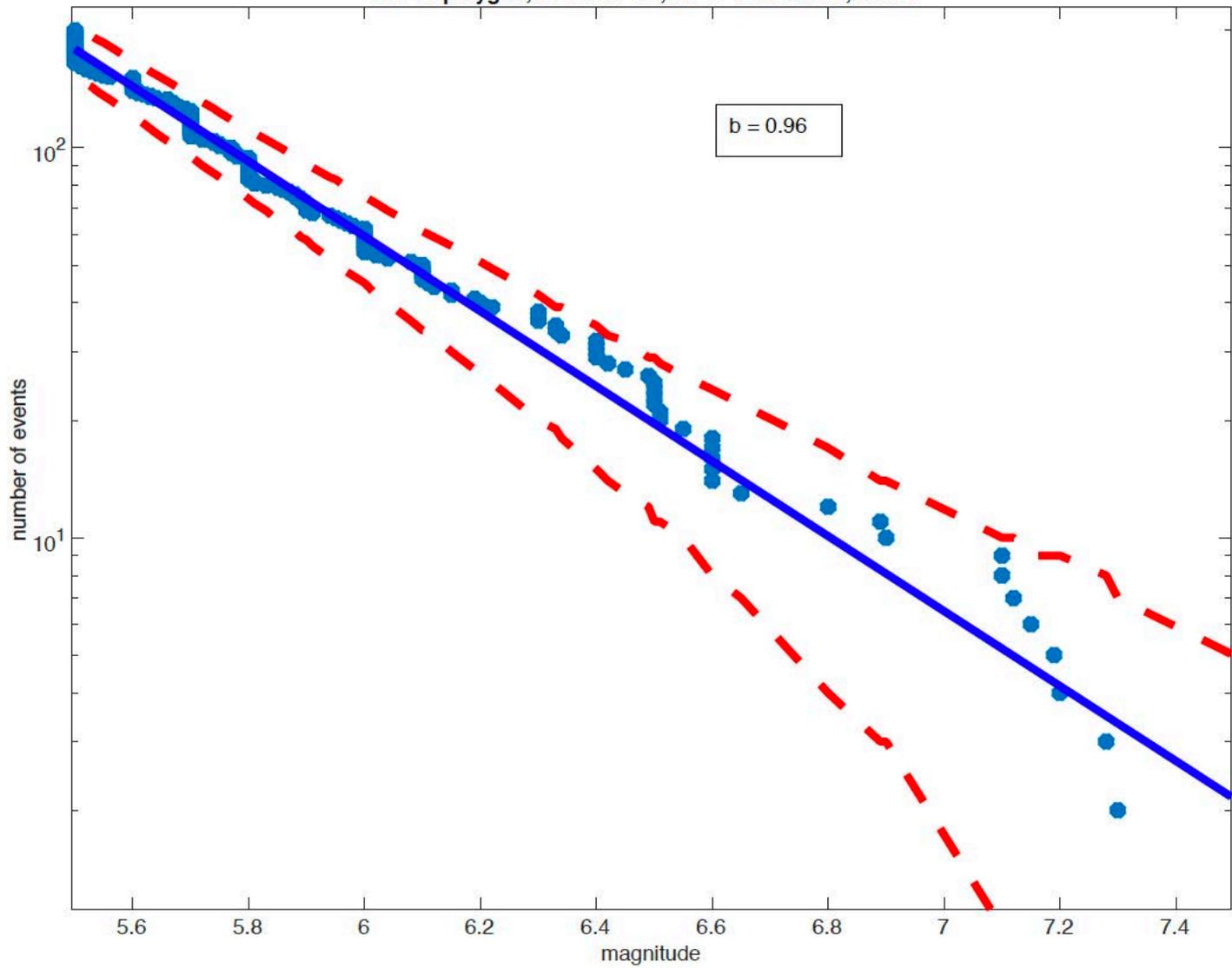
p. 533... **The timing of the two youngest events requires that interpretations other than co-seismic rupture be considered.** Event E0 is believed to have most likely occurred during the past 150 yr or so, which is the well-recorded part of the historical period. The lack of a large historical earthquake in the area that could have produced surface rupture on the Claremont fault indicates that this deformation is most likely not due to co-seismic rupture. We instead interpret this deformation to be **the result of either surface fractures and compaction of the sag due to shaking from a nearby earthquake, groundwater withdrawal in the area that has caused subsidence and ground fissures in some parts of the San Jacinto Valley (Morton, 1977), fault creep, or triggered slip.**

Conclusions

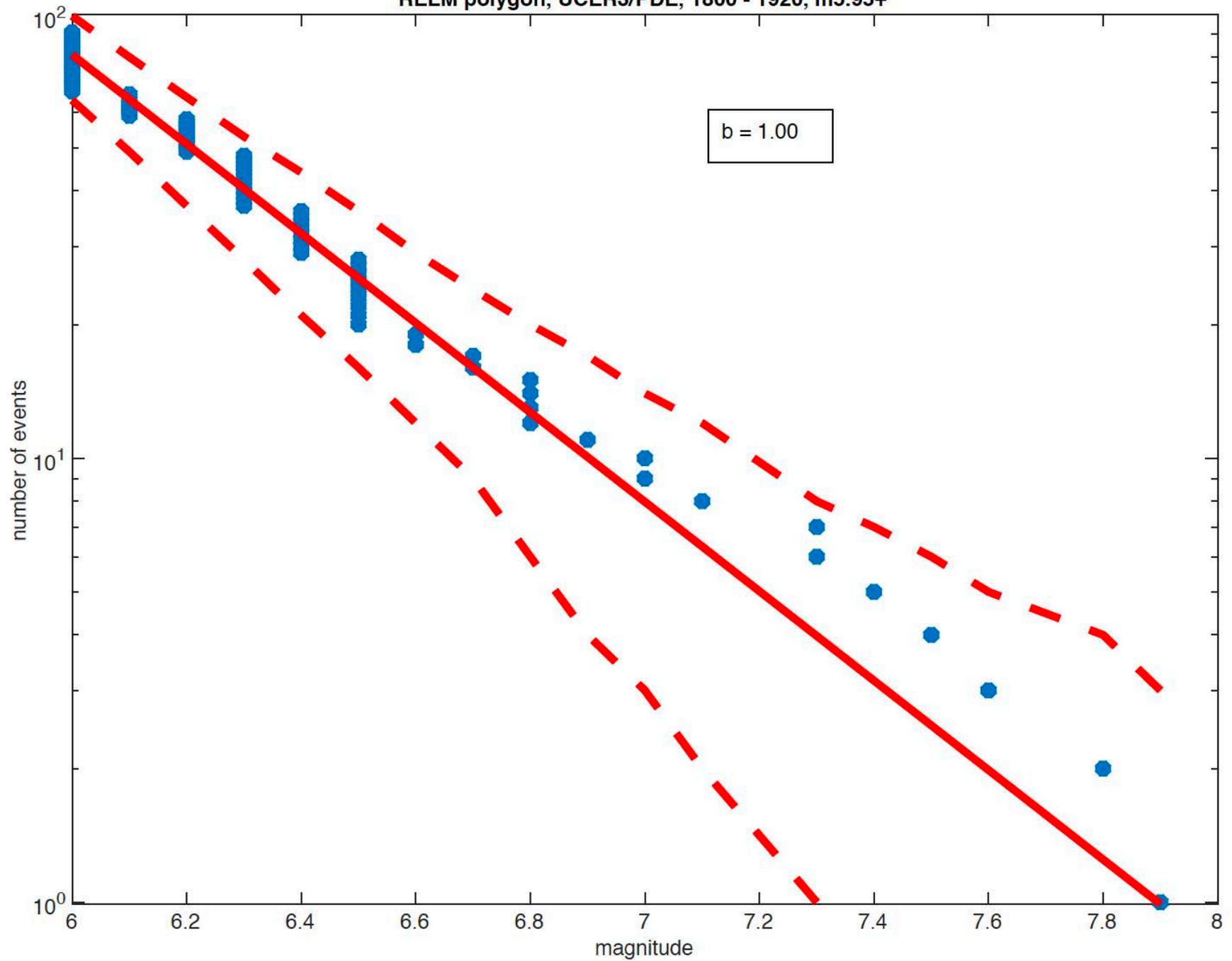
- Statewide, California is not overdue for m7+ earthquakes.
- M7+ rate is about 0.09 per year; scary enough
- Network seismology appears to reduce reports of paleo events.
- It's the last (open) hiatus, not just any hiatus, that matters in statistical tests,
- Many paleo events are not earthquakes
- Recurrence statistics for individual faults are meaningless, because they depend on questionable data.

EXTRAS

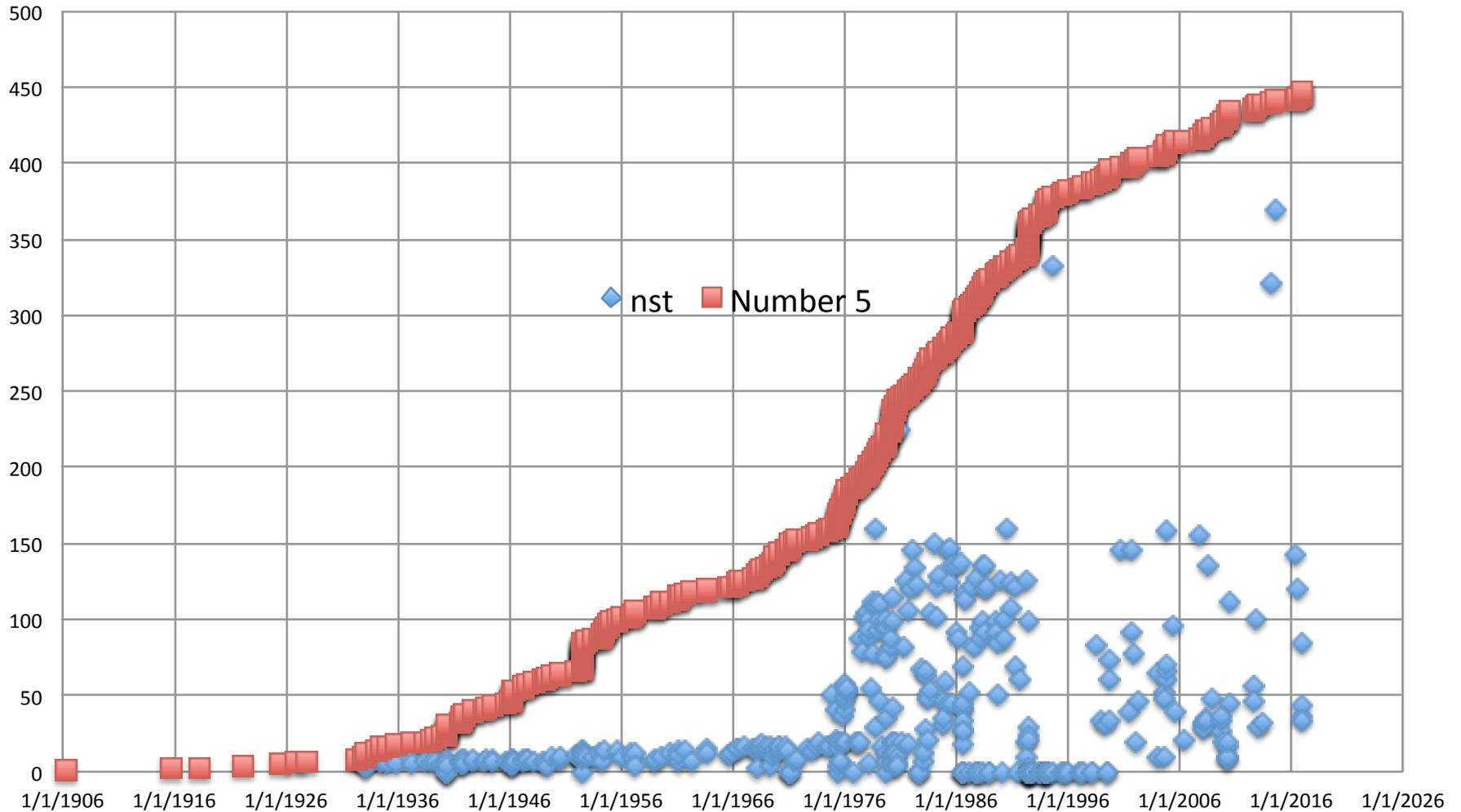
RELM polygon, UCER3/PDE, 1920 - 2019/09/01, m5.5+



RELM polygon, UCER3/PDE, 1800 - 1920, m5.95+



Comcat: California number of stations used and cumulative m5+



Southern San Andreas Fault Seismicity is Consistent with the Gutenberg–Richter Magnitude–Frequency Distribution, Morgan Page and Karen Felzer Bulletin of the Seismological Society of America (2015) 105 (4): 2070-2080.

...small earthquake rates on the southern San Andreas have been low in the instrumental era, **$M \geq 7$ earthquakes have also been completely absent**, even though the average repeat time for such events on the fault has been surpassed (Biasi and Weldon, 2009a). In fact, **large earthquakes being overdue on those faults** for which small earthquake rates are low appears to be universally observed on faults hypothesized to be characteristic across California (Jackson, 2014).

Jackson D. (2014). Did someone forget to pay the earthquake bill? Seismol. Res. Lett. 85, 421.

COMPARED TO WHAT?

- 1000 years up to 1918 (last paleo event)
- 1800 – 1918 (populated but no seismic network)
- 1933 – 1976 (half of “seismic network age”)