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LETTERS

Stress changes from the 2008 Wenchuan earthquake and increased hazard in the Sichuan basin

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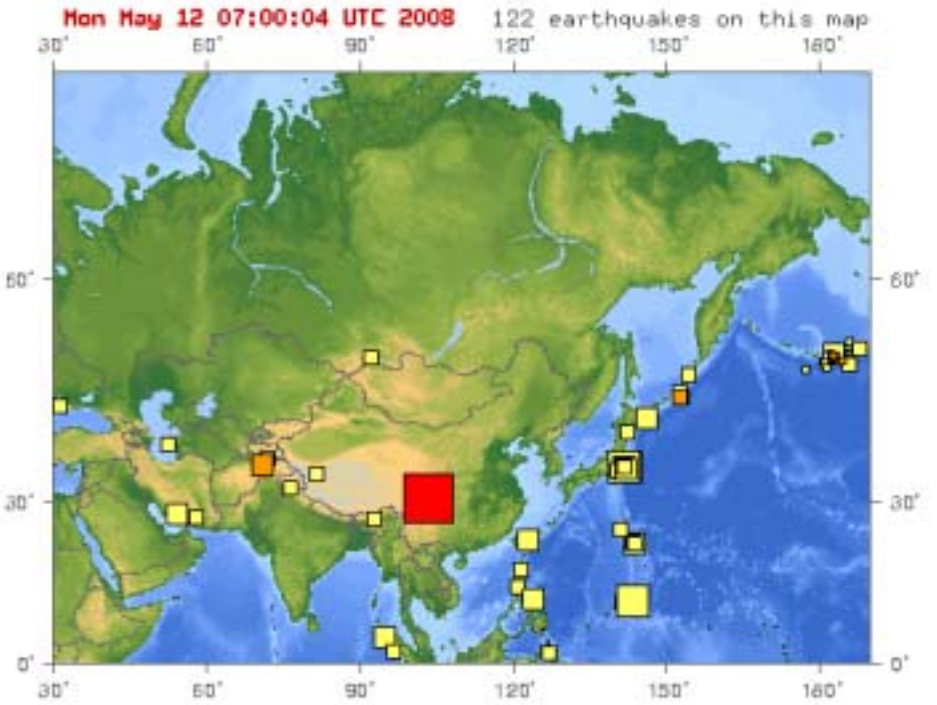
Wenchuan earthquake

- May 12, 2008
- Magnitude 7.9
- Eastern edge of the Tibetan plateau
- Western Sichuan basin in China

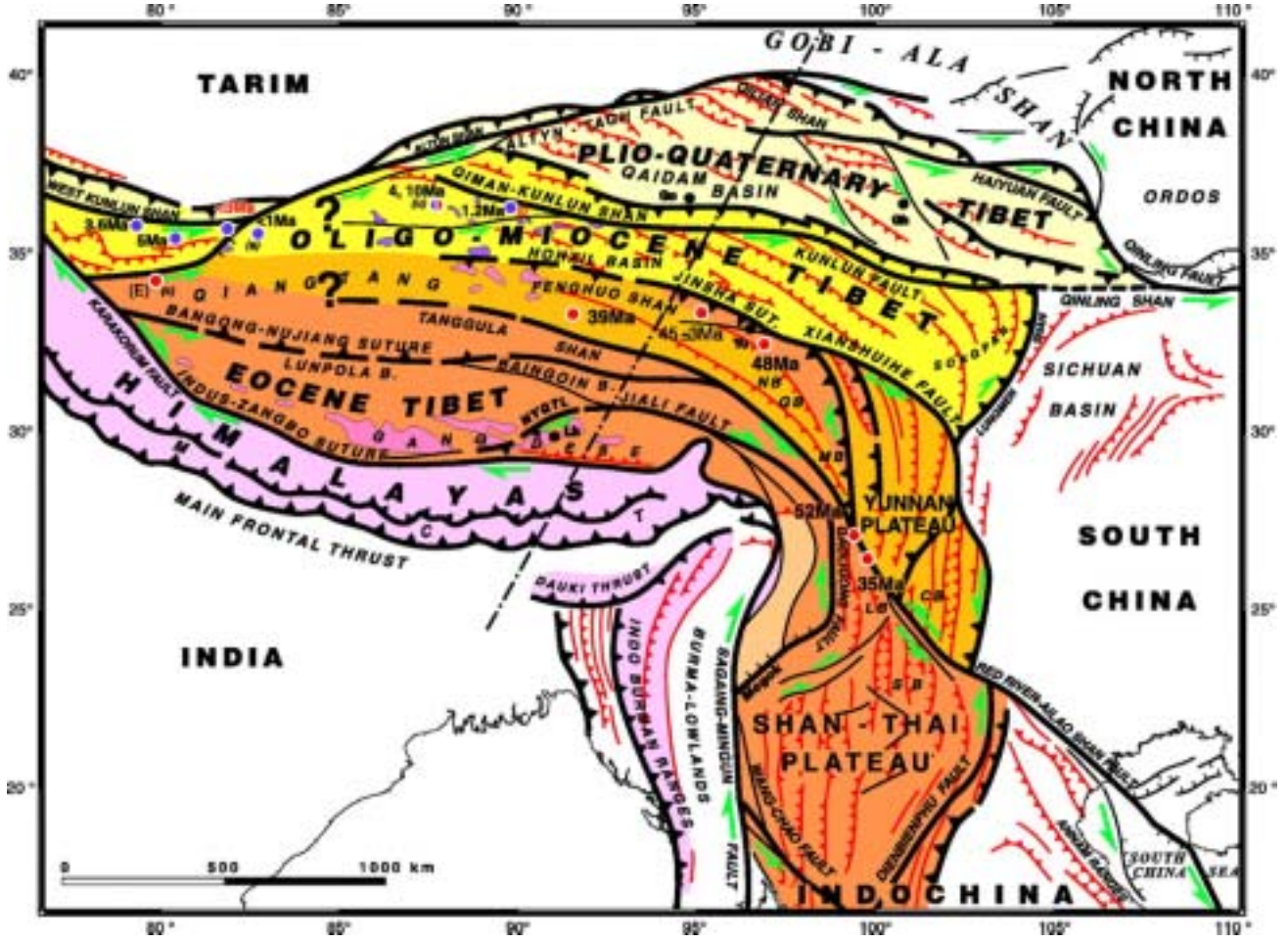


Location of Wenchuan

Location of Wenchuan

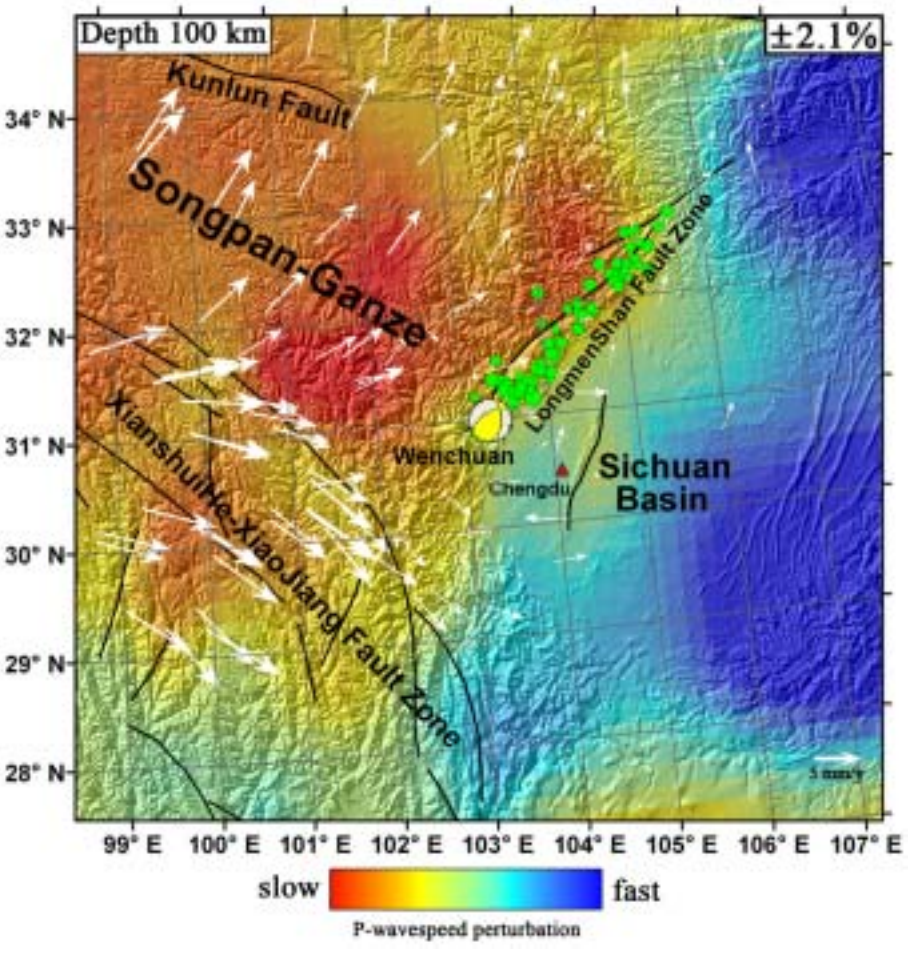
Boundary between Sichuan Basin (**四川盆地**) and Longmen Mountain (**龍門山**)

Tectonic setting



Because India moves to the NNE, Tibet is pushed and lifted.
There is thrust between Tibet and South China.

Epicenter of Wenchuan Earthquake



LongmenShan
Fault zone

This paper

- Calculations of the coseismic stress changes
  - Resulted from the 12 May event using models of the neighboring faults
  - Coulomb failure stress calculation
- Many faults indicate significant stress increases.
- Locate fault sections with relatively higher odds of producing large aftershocks.

Coulomb failure stress

- $\Delta \boldsymbol{\tau} = |\Delta \boldsymbol{\tau}_f| + \boldsymbol{\mu}(\Delta \boldsymbol{\sigma}_n - \Delta p)$
  - $\Delta \boldsymbol{\tau}_f$: shear stress change on the receiver fault
  - $\boldsymbol{\mu}$: friction coefficient
  - $\Delta \boldsymbol{\sigma}_n$: normal stress change acting on the target fault
  - Δp : pore pressure change
- Sum of shear stress and normal stress multiplied by friction coefficient

Estimation of Change in Coulomb failure stress

- Stress change calculation
  - Earthquake source slip model
  - using a boundary element method
- Modelling of target fault
  - Mapped traces extended to 20 km
  - in a range of possible dip angle from structural mapping

Rough estimation of Coulomb failure stress

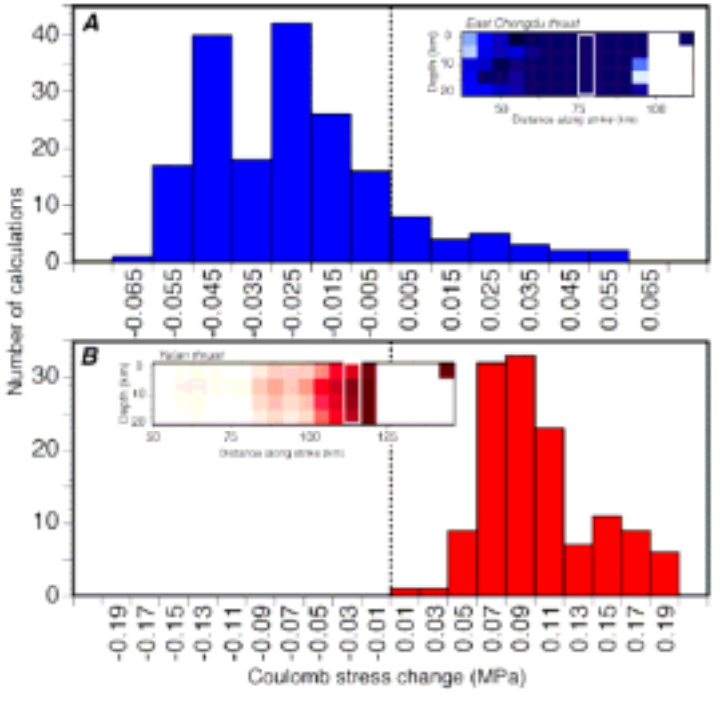
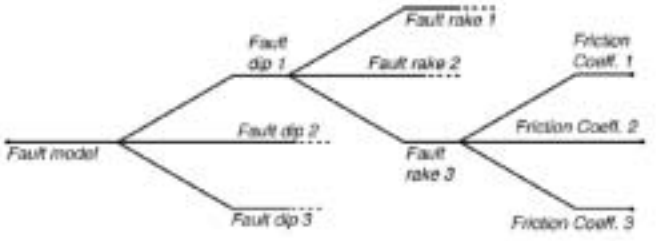


Figure S2 | Example distributions of stress change calculations. Histograms are taken from 5-km wide sections (shown by white boxes on faults) from mean increased and mean decreased portions of a, the thrust fault southeast of Chengdu, and b, the thrust fault at Ya'an. Even with some overlap and a broad range of possible stress change values, calculated relative stress changes are significantly either positive or negative (dash vertical line separates positive and negative stress changes).

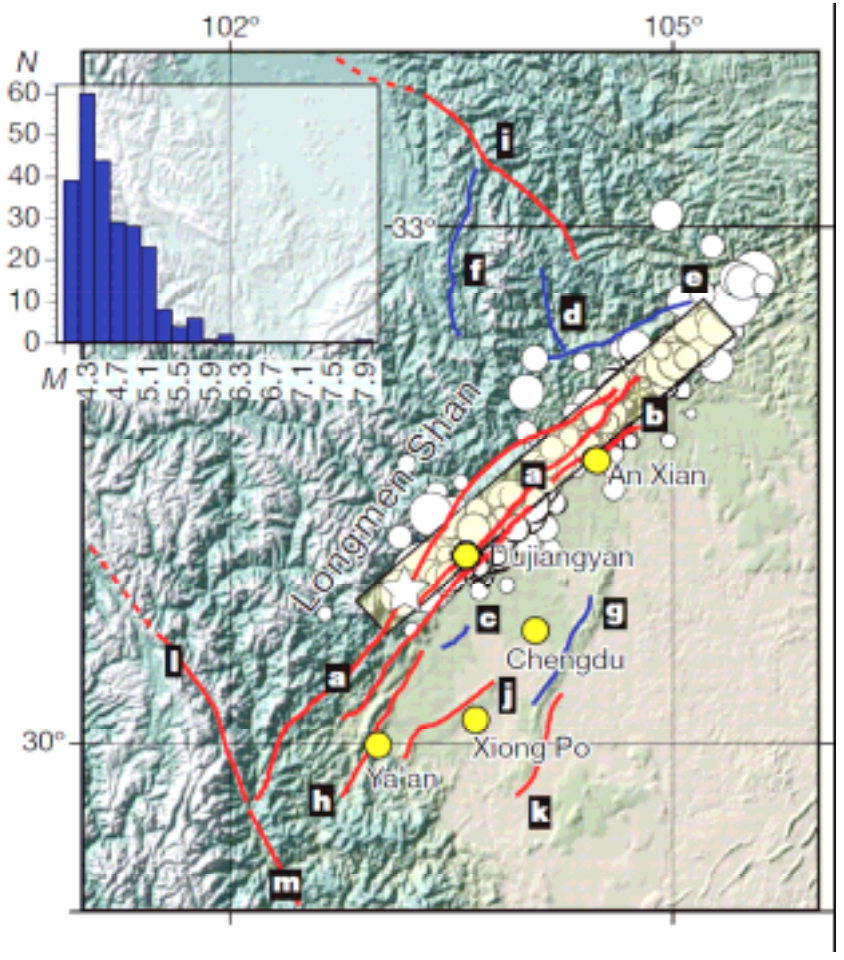
- With varing dip, rake and friction coefficient, CFS's are calculated.
- From the distribution of CFS, probably CFS are estimated.



Map code	Fault	dip range	rake range	friction range	Number calcs.
a	Wenchuan	70-45 NW	180-135	0.0-0.8	12
c	Deyi	90-70 NW	180-135	0.0-0.8	12
d	Huya fault	55-65W	70-90	0.0-0.8	12
e	Qingchuan fault	70-90 NW	150-180	0.0-0.8	12
f	Minjiang fault	55-65W	70-90	0.0-0.8	12
g	East Chengdu thrust	70-30 SE	135-90	0.0-0.8	18
h	Ya'an thrust	70-45 NW	180-135	0.0-0.8	12
i	Kunlun fault	75-90NE	0-45	0.0-0.8	12
j	Xiong Po thrust	30-10 SE	135-90	0.0-0.8	18
k	Southeast Chengdu thrust	30-10 SE	135-90	0.0-0.8	18
l	Xianshuihe	70SW-70NE	0-45	0.0-0.8	18
m	Shimian fault	70SW-70NE	0-45	0.0-0.8	18
	Qinling fault	70-90 SW	0-45	0.0-0.8	12

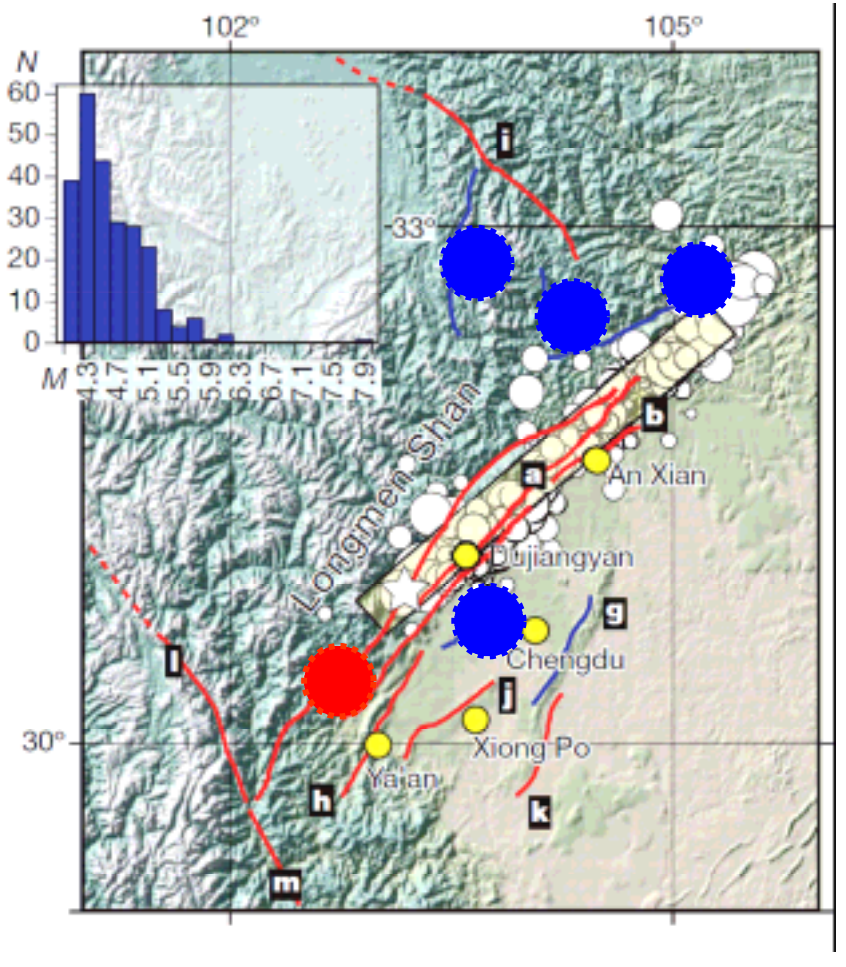
Figure S1 | Primary sources of uncertainty in Coulomb stress change calculations and parameter ranges for major fault zones in the Sichuan basin. Diagram indicates calculation sets for each fault dip, rake, and friction coefficient. Mean stress changes and fault locations are shown in main text Fig. 1.

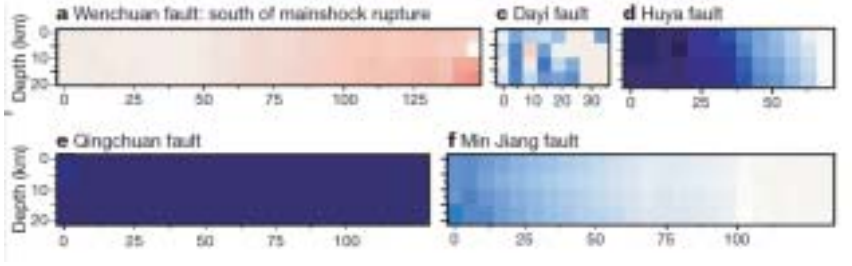
Fault distribution near the epcienter



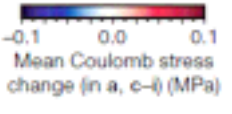
- a: Wenchuan fault
- b: Penguan fault
- c: Dayi fault
- d: Huya fault
- e: Qingchuan fault
- f: Min Jiang fault
- g: East Chengdu thrust
- h: Ya'an thrust
- i: Kunlun fault
- j: Xiong Po fault
- k: Southeast Chendu fault
- l: Xianshuihe fault
- m: Shimian fault

Changes in Coulomb stress around the mainshock

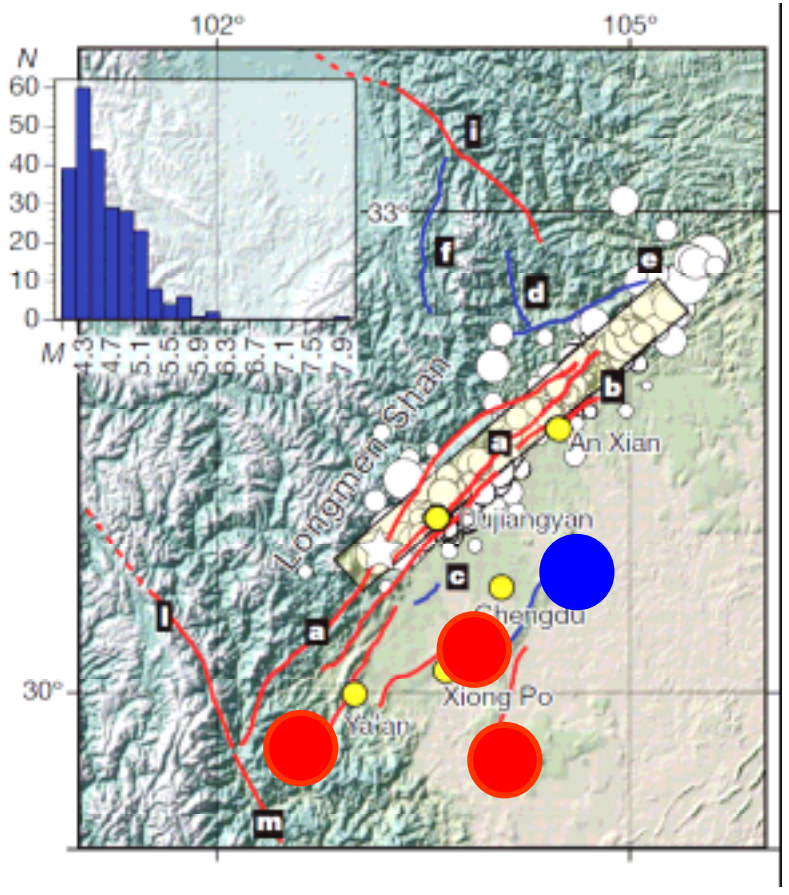


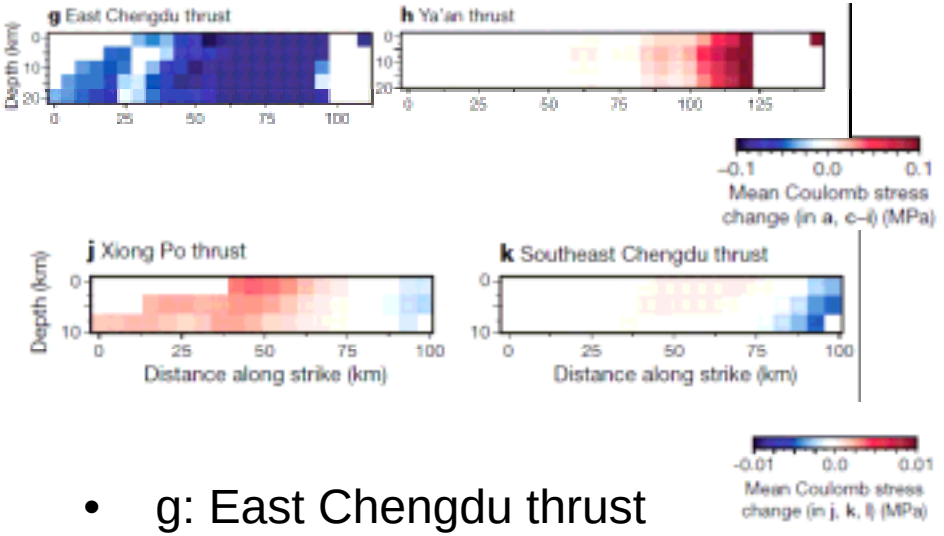


- a: South part of Wenchuan fault
  - increased by up to 0.1 MPa
- b: Penguan fault
  - Too close to the mainshock rapture to analyze
  - unclear whether it was evolved in the mainshock rapture
- c: Dayi fault
  - reduced
- d: Huya fault
  - reduced
- e: Qingchuan fault
  - reduced
- f: Min Jiang fault
  - reduced



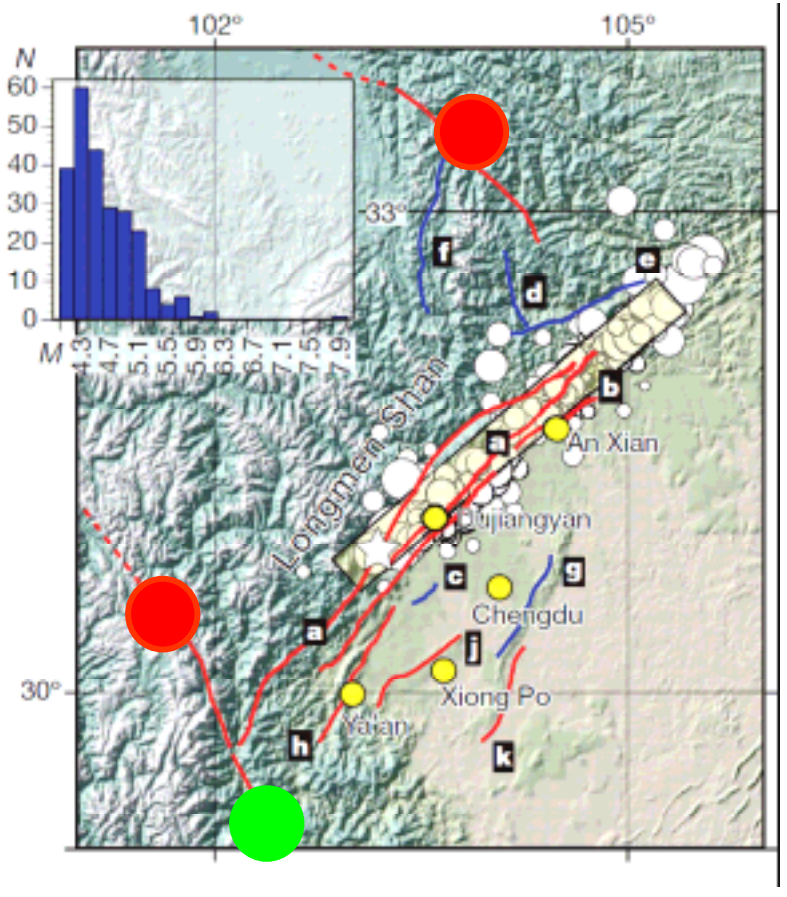
Changes in Coulomb stress in Sichuan basin

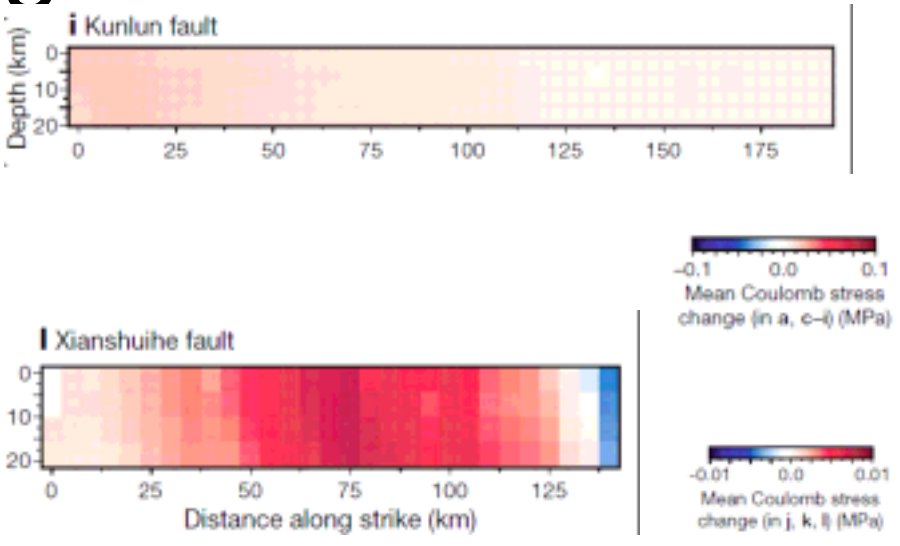




- g: East Chengdu thrust
  - decrease
- h: Ya'an thrust
  - increase
- j: Xiong Po fault
  - increase
- k: Southeast Chendu fault
  - increase

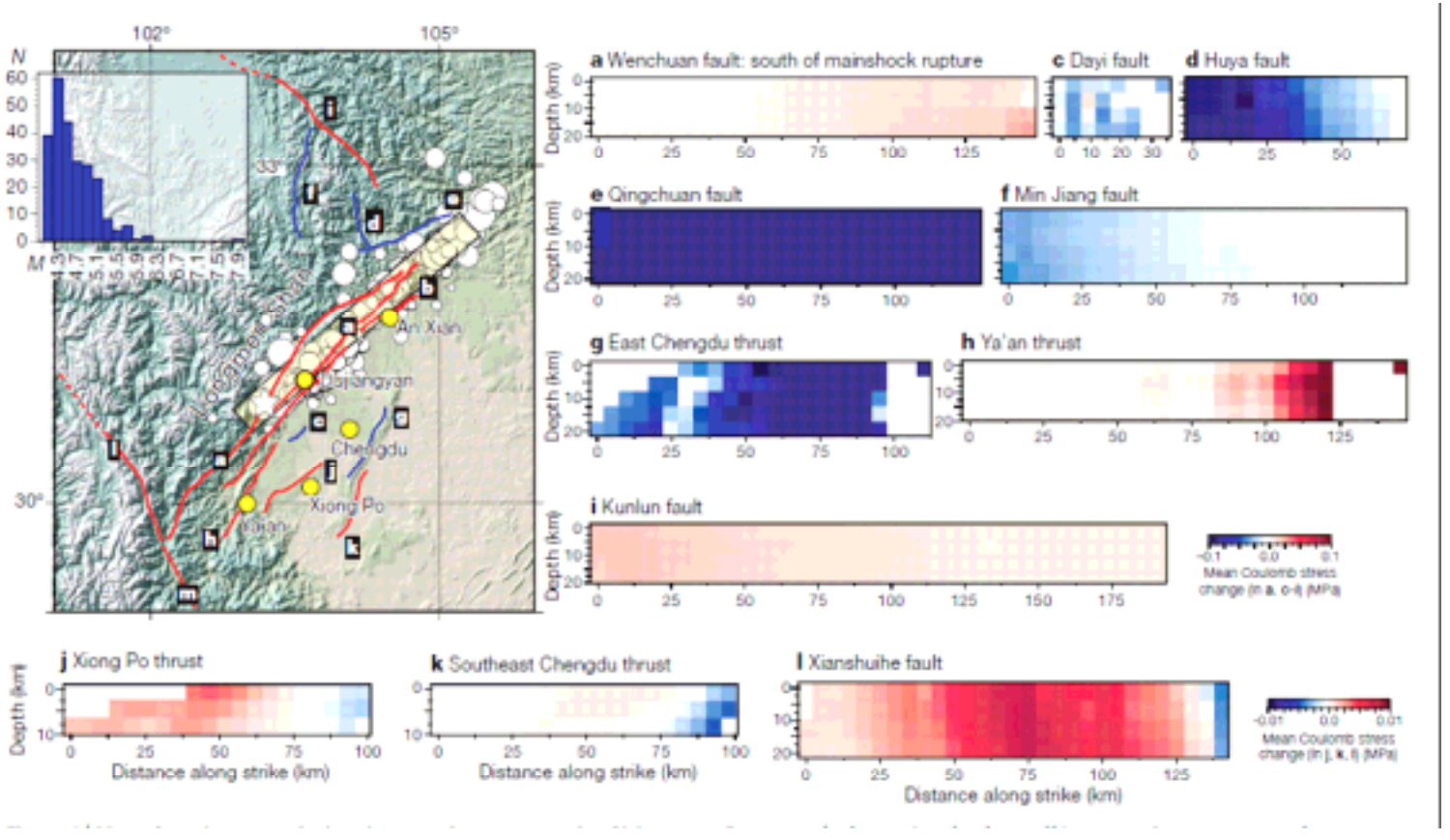
Changes in Coulomb stress around Longmen Shan





- i: Kunlun fault
  - increase, especially northwest
- l: Xianshuihe fault
  - increase over 125 km
  - decrease at the juction with Shimian fault
- m: Shimian fault
  - negligible change

Summary of CFS



- CFS increases in the southern Sichuan Basin

Ending Remarks

- Aftershock activity
  - within the mainshock rapture area
  - largest: two M=6 events
- M>7 earthquakes changes seismicity-rate over distance of 200-250 km from the mainshock
- The 12 May 2008 M=7.9 earthquake may cause large aftershocks in the near future
  - the failure stress increases on the important faults within and around the Sichuan basin.