Earthquake Risk in Continental Interiors

Philip England and James Jackson

http://ewf.nerc.ac.uk

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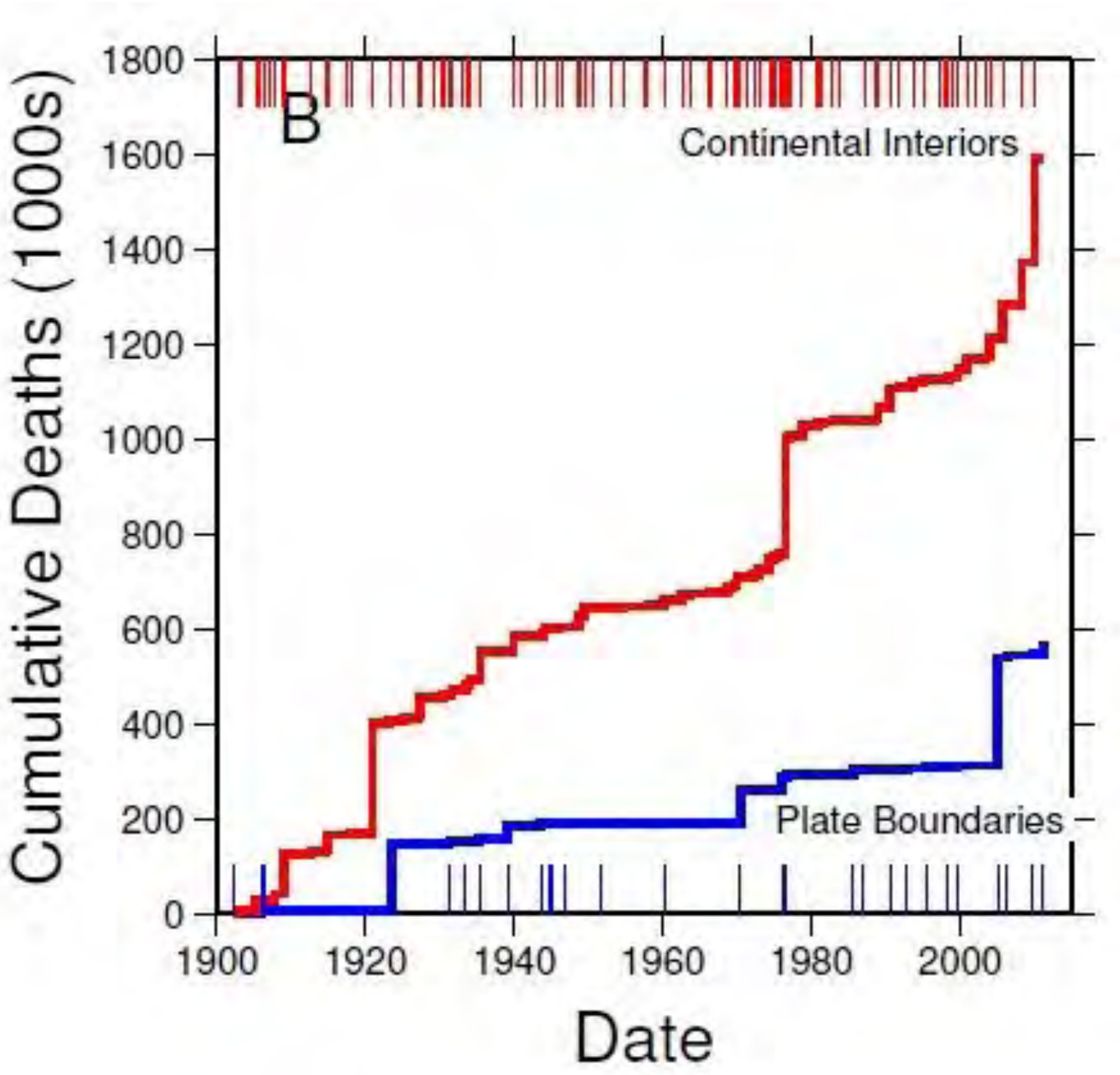
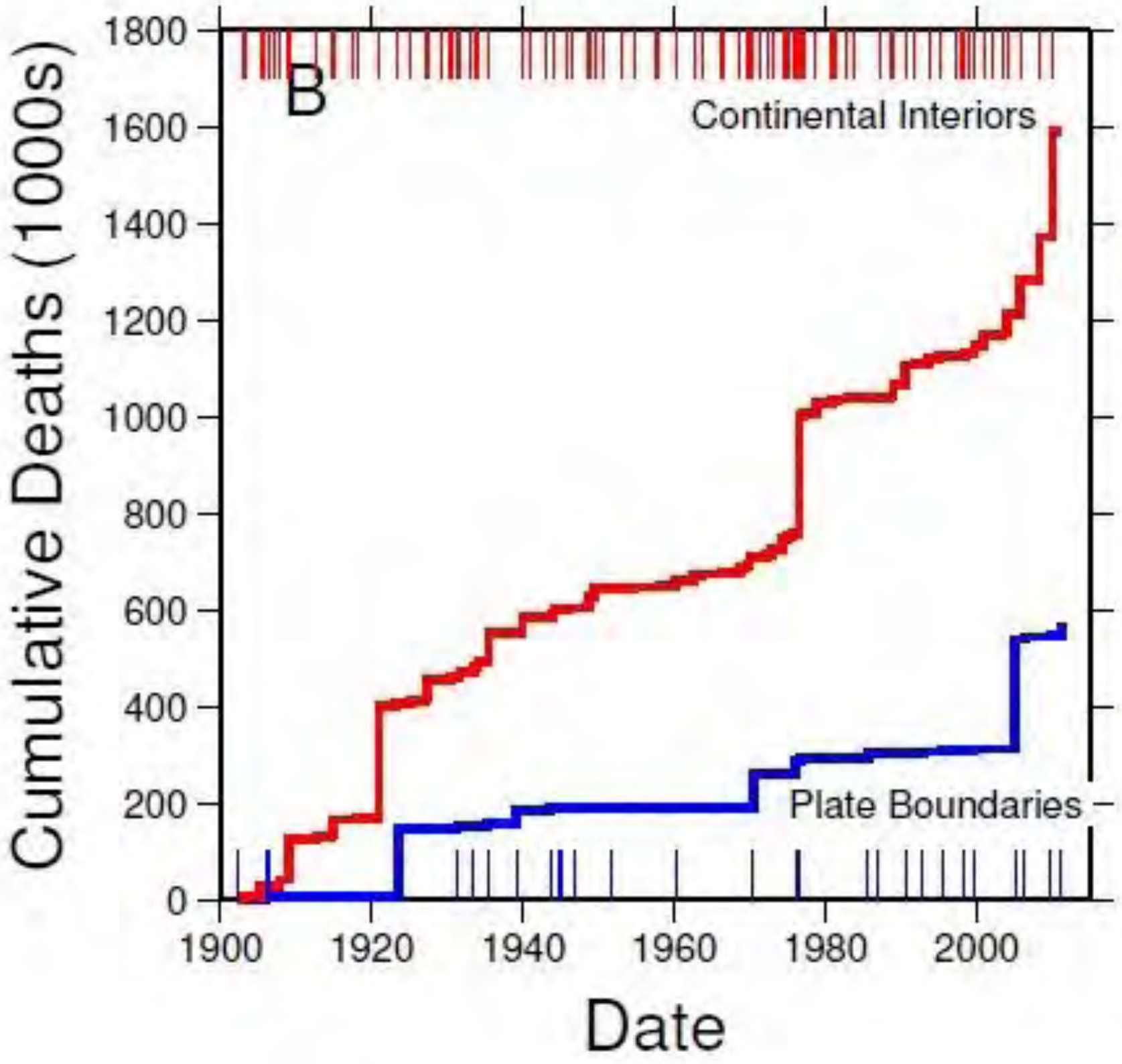
The Problem


Cumulative Deaths (1000s)
1800
1600
1400
1200
1000
800
600
400
200
0
B
Continental Interiors
Plate Boundaries
1900
1920
1940
1960
1980
2000
Date

The Problem



2—2.25 million people died in earthquakes since 1900.

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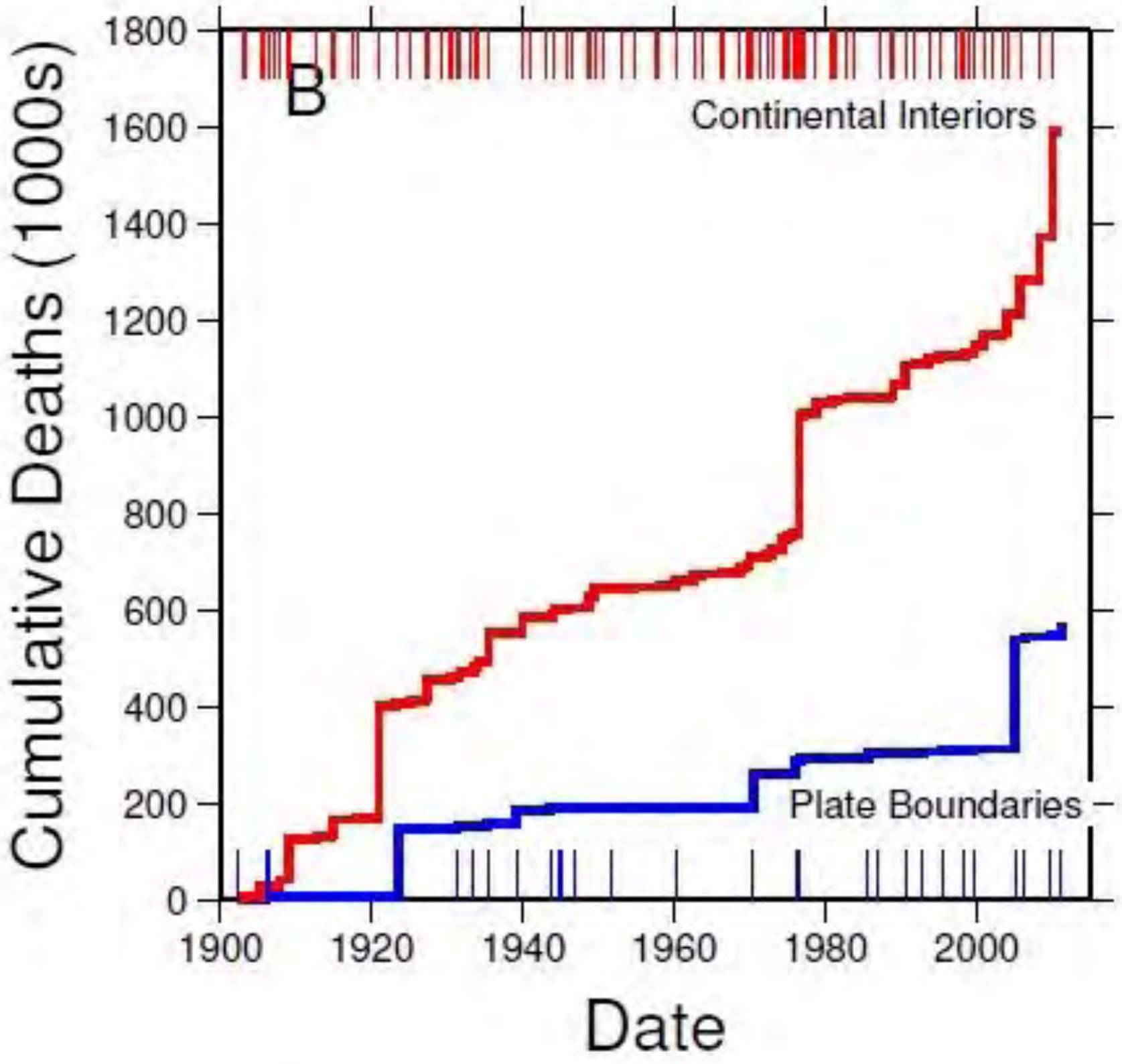

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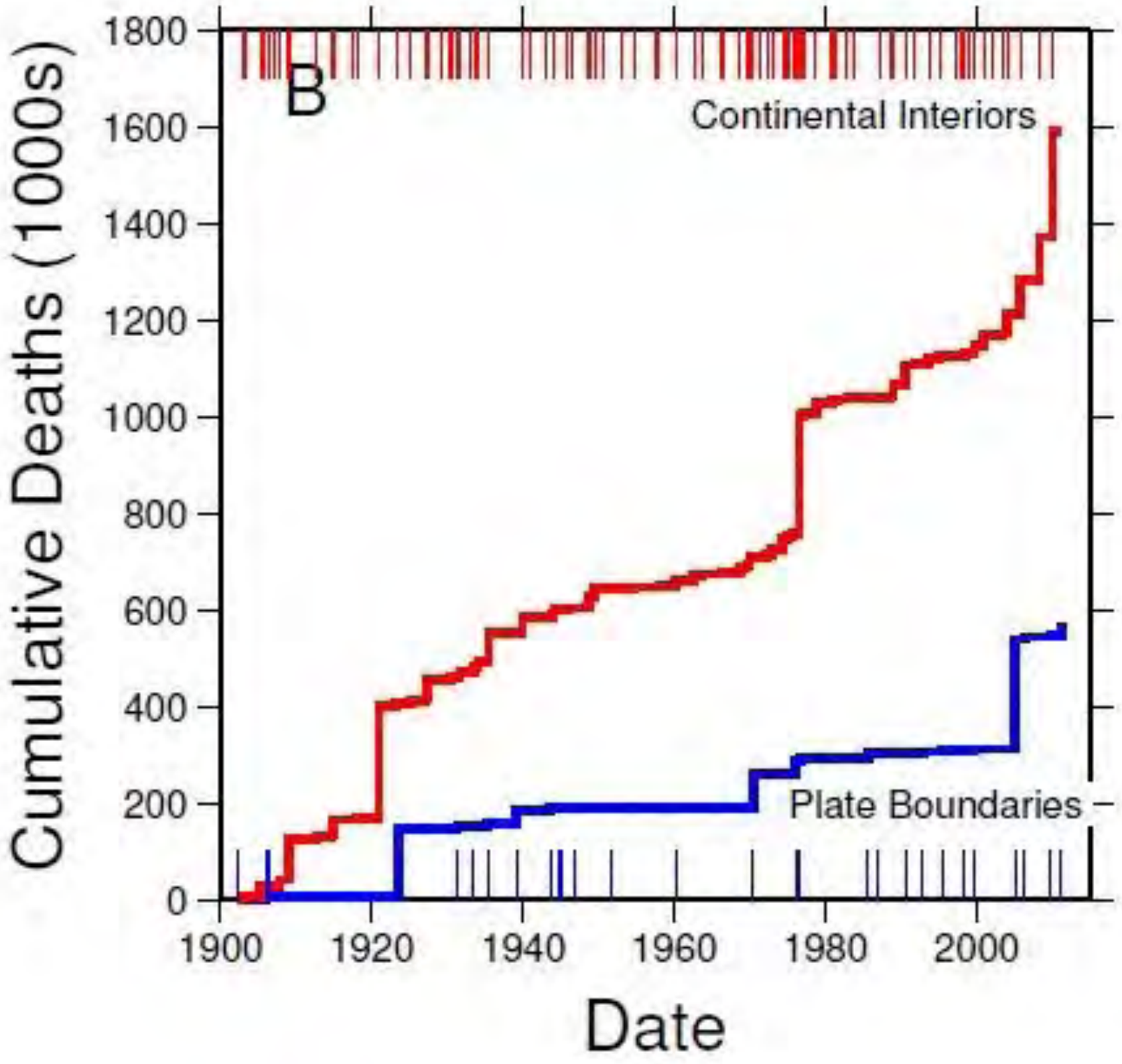

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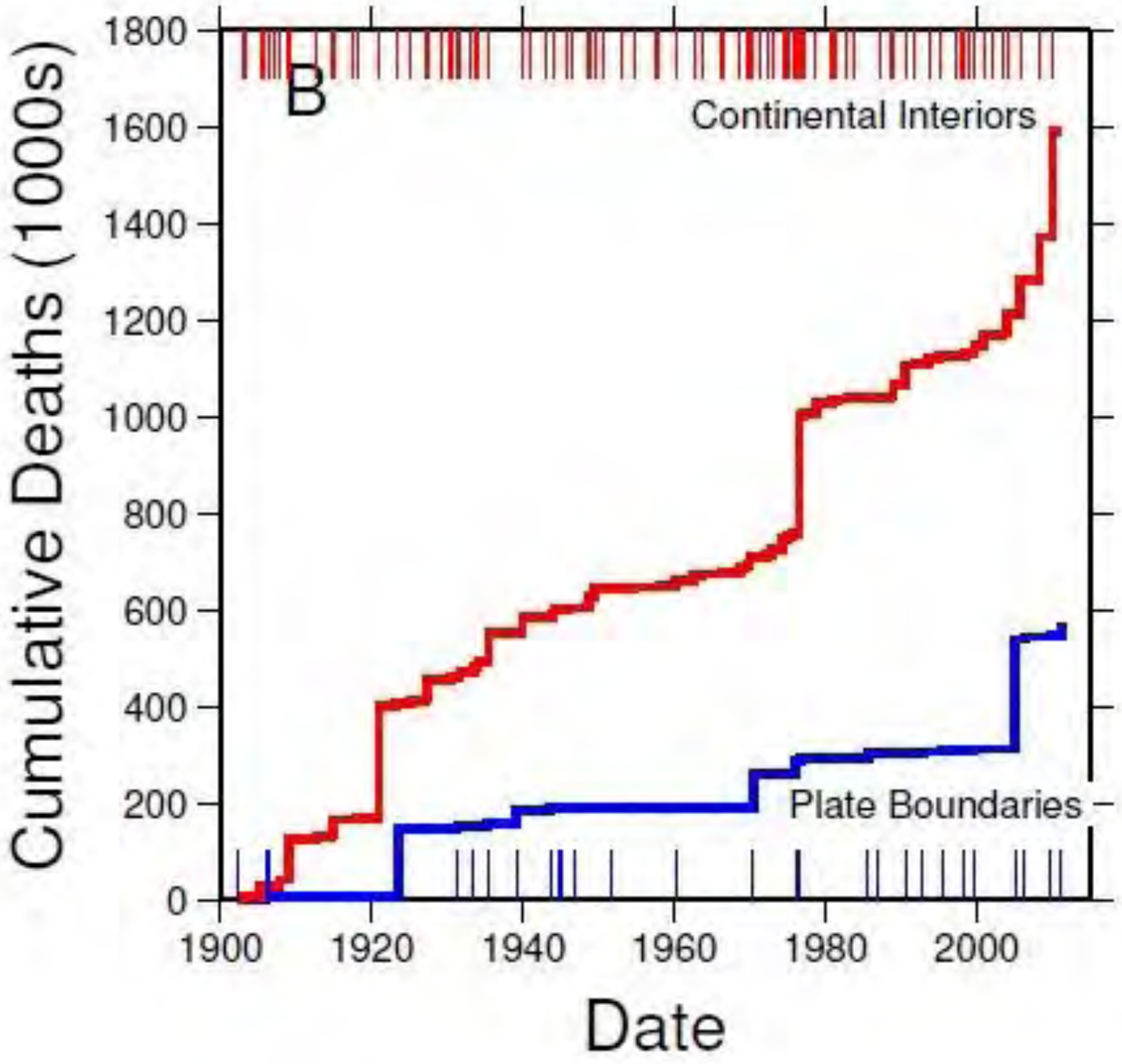

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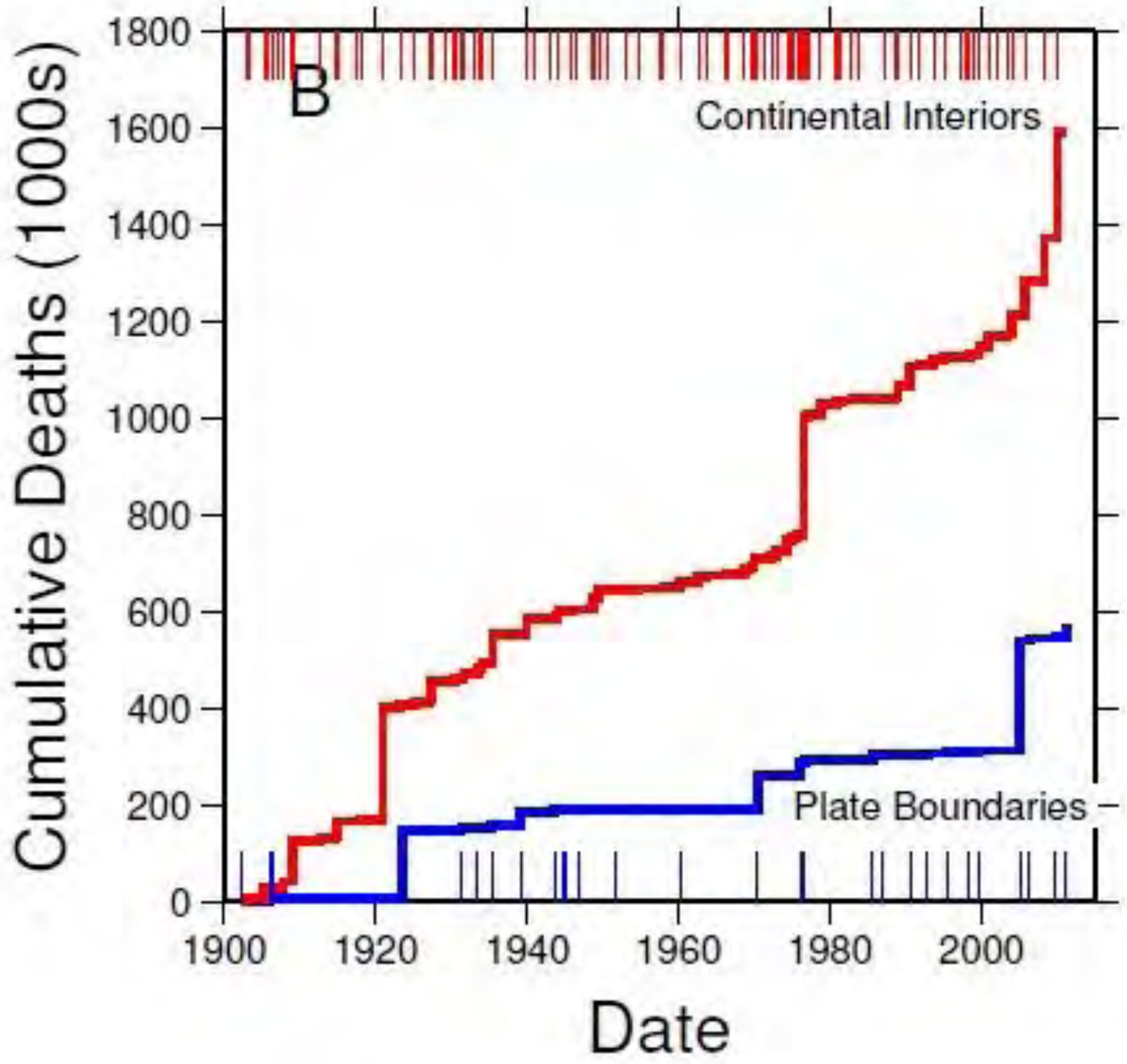

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And the problem is getting worse.

This is not the usual pattern of interaction between science and society.

The State of the Art

Sendai 2011

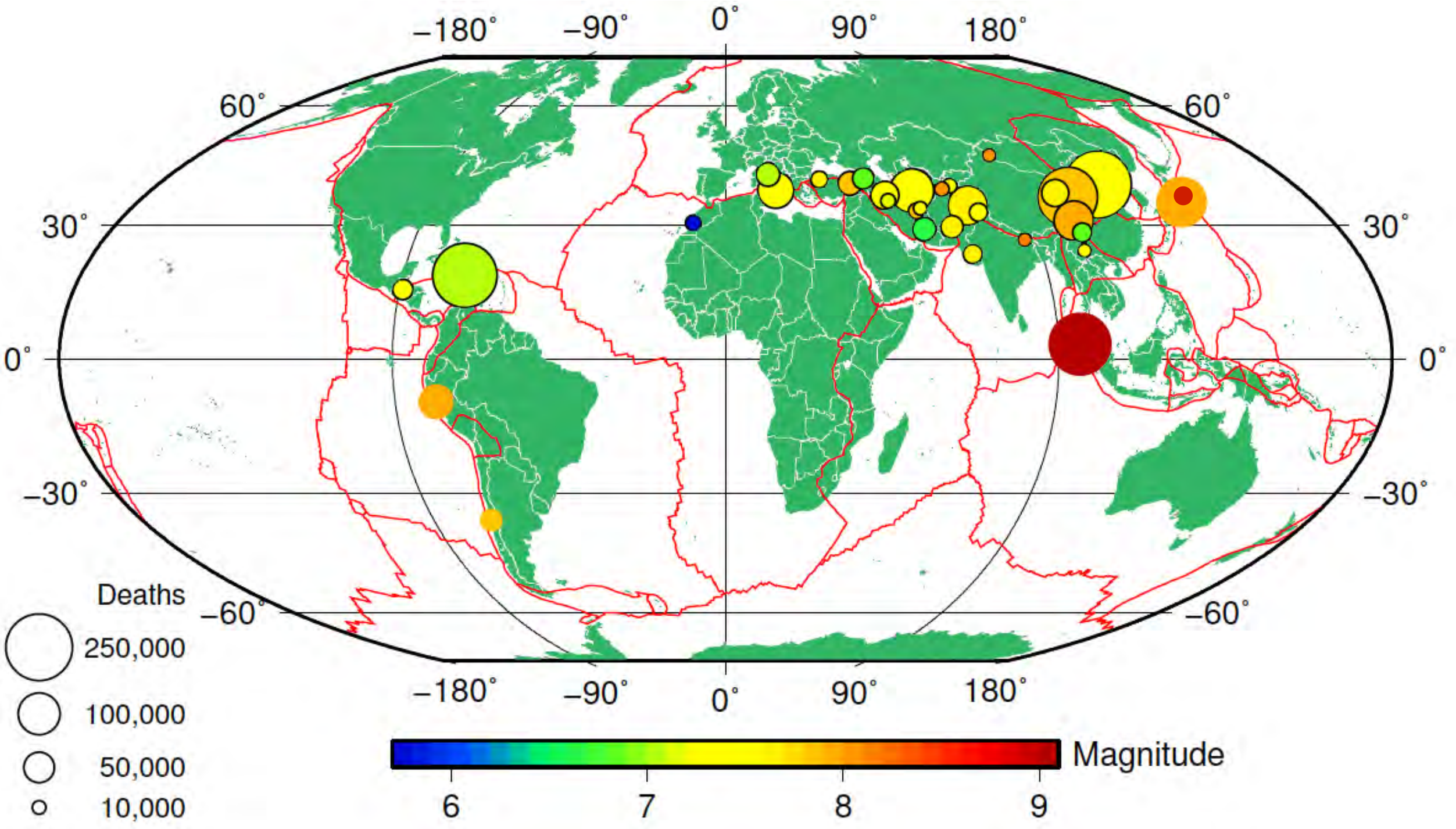
Death rate 0.4% in MVIII+ shaking. (Mostly tsunami.)

The State of the Art

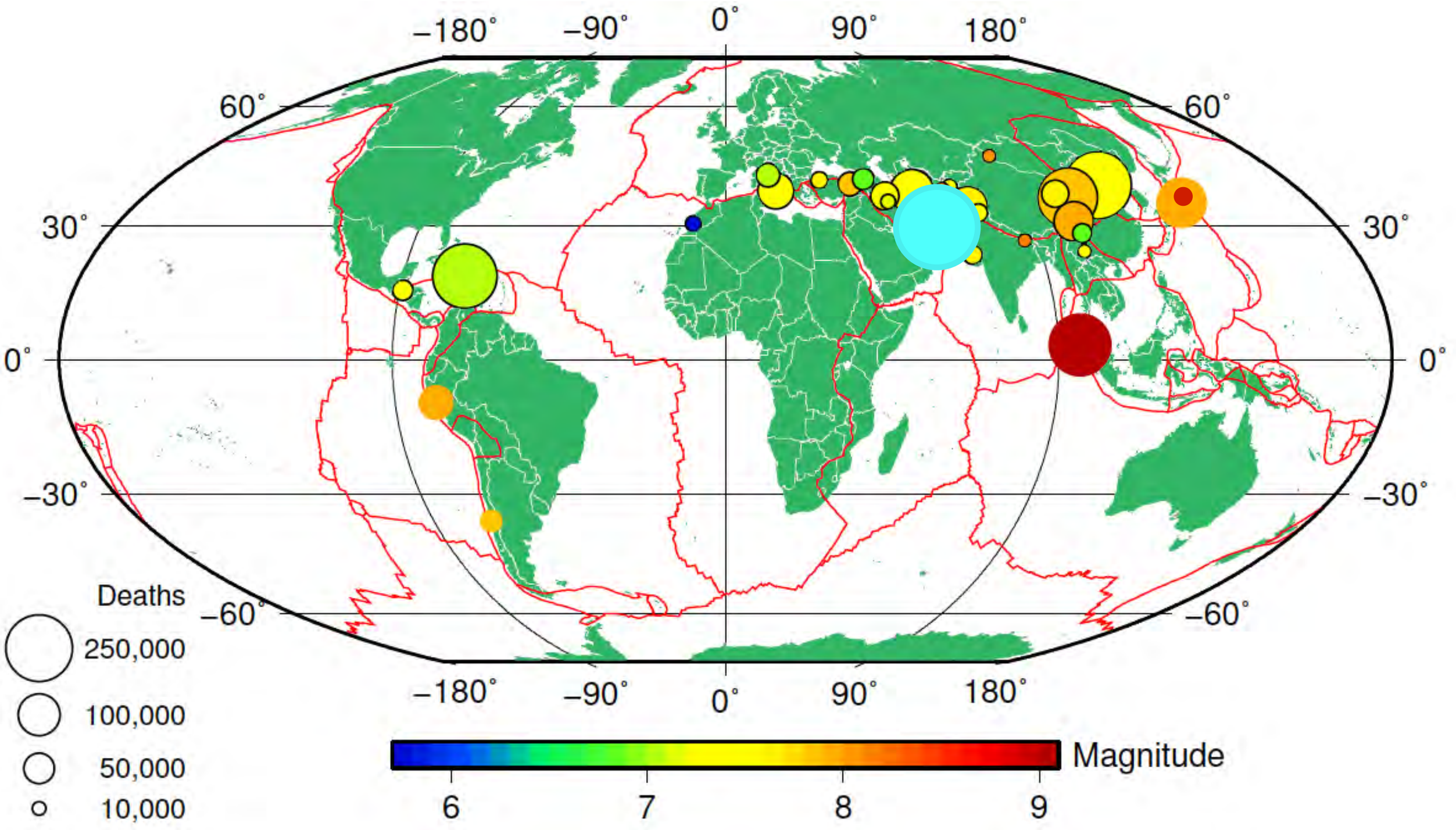
Christchurch 2011

Death rate in MVIII+ shaking 0.1%

Last 100 Years > 1,000 Deaths



Last 100 Years > 1,000 Deaths



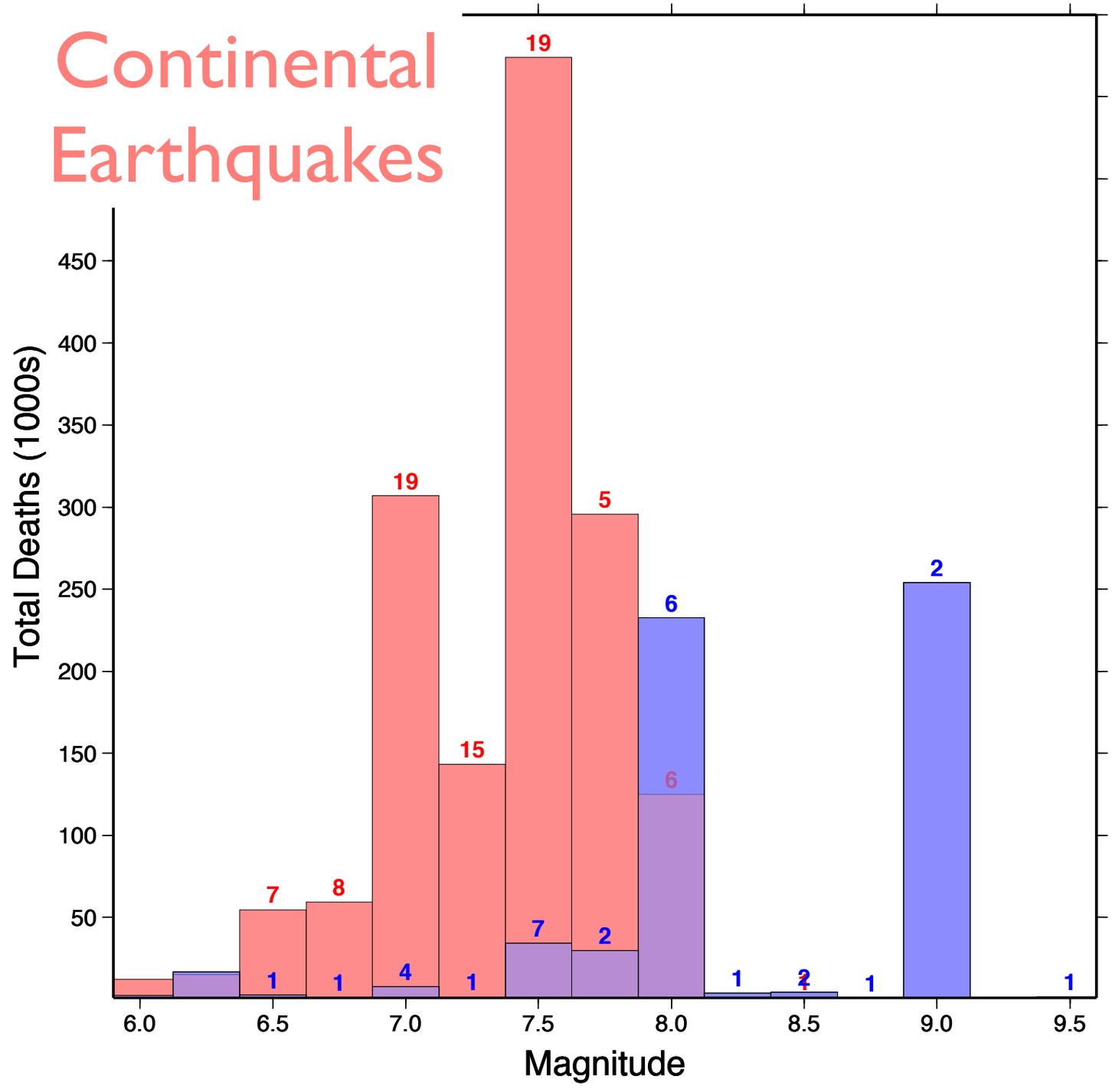
Bam 2003, M6.6: Death rate 30%. >26,000 deaths

Devastating Earthquakes

1) Plate Boundaries
   Faults of known location
   slip at 10-100 mm/year

2) Continental Interiors
   Fault locations frequently unknown
   Slip at 0.1- 1mm/yr

Last 100 Years > 1,000 Deaths



Continental Interiors

The killers are M ~7 Earthquakes:

- 3 metres of slip
- Slip at 0.1- 1mm/yr
- 1/3,000 1/30,000 yr

At an individual location:

- Earthquakes are extremely rare devastating events.
- Collective memory fades.
- Lack of effective action.

Earthquakes Without Frontiers

Universities of Cambridge, Durham, Hull, Leeds, Northumbria & Oxford

Overseas Development Institute

British Geological Survey

http://ewf.nerc.ac.uk

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OBJECTIVES

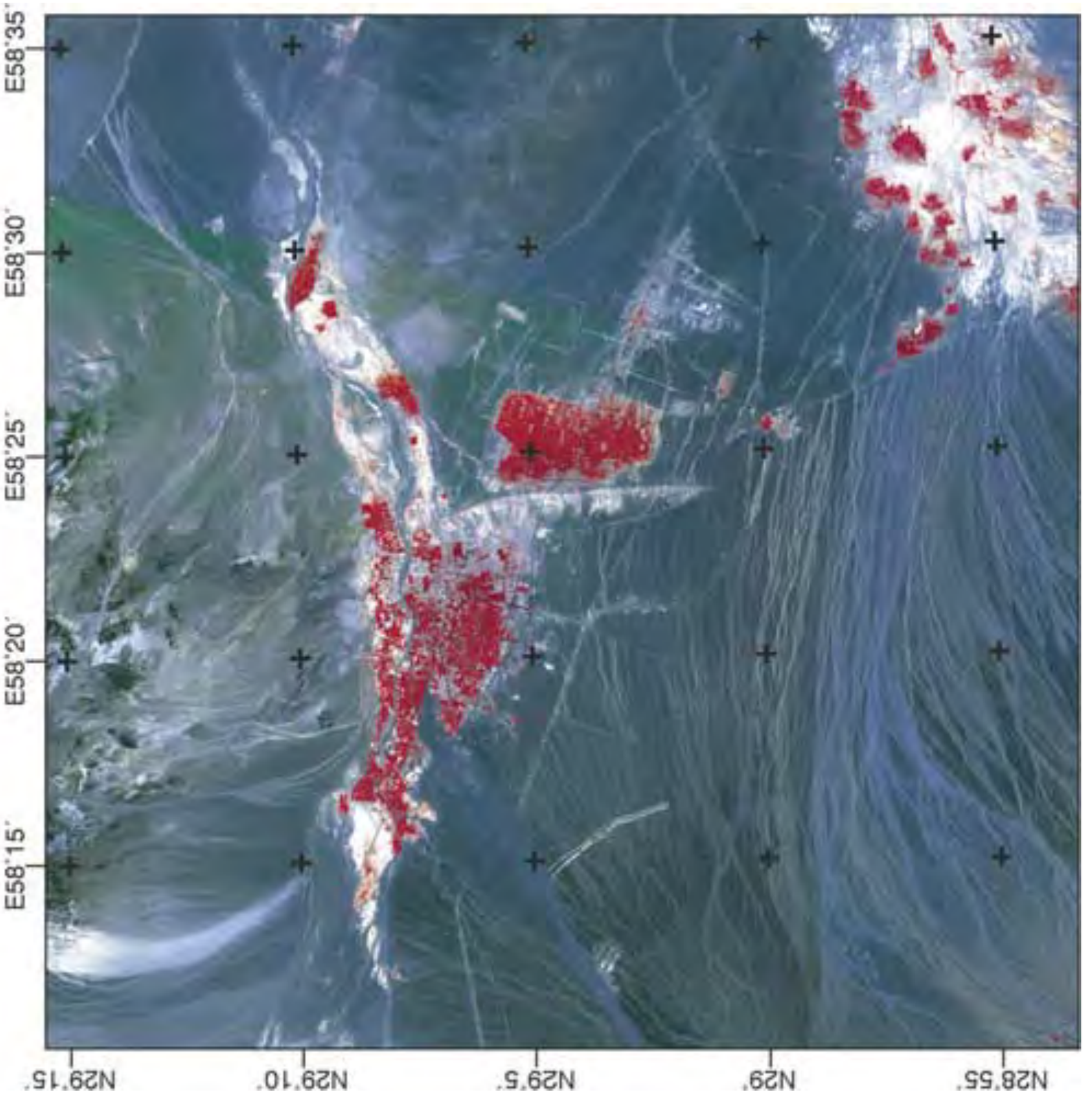
- Knowledge of the distributions of primary and secondary seismic hazards in the continental interiors.
- Established pathways to increased resilience in exposed populations in pilot areas.
- Uptake of research into policy and practice, in the short-term and long-term.

The State of the Art

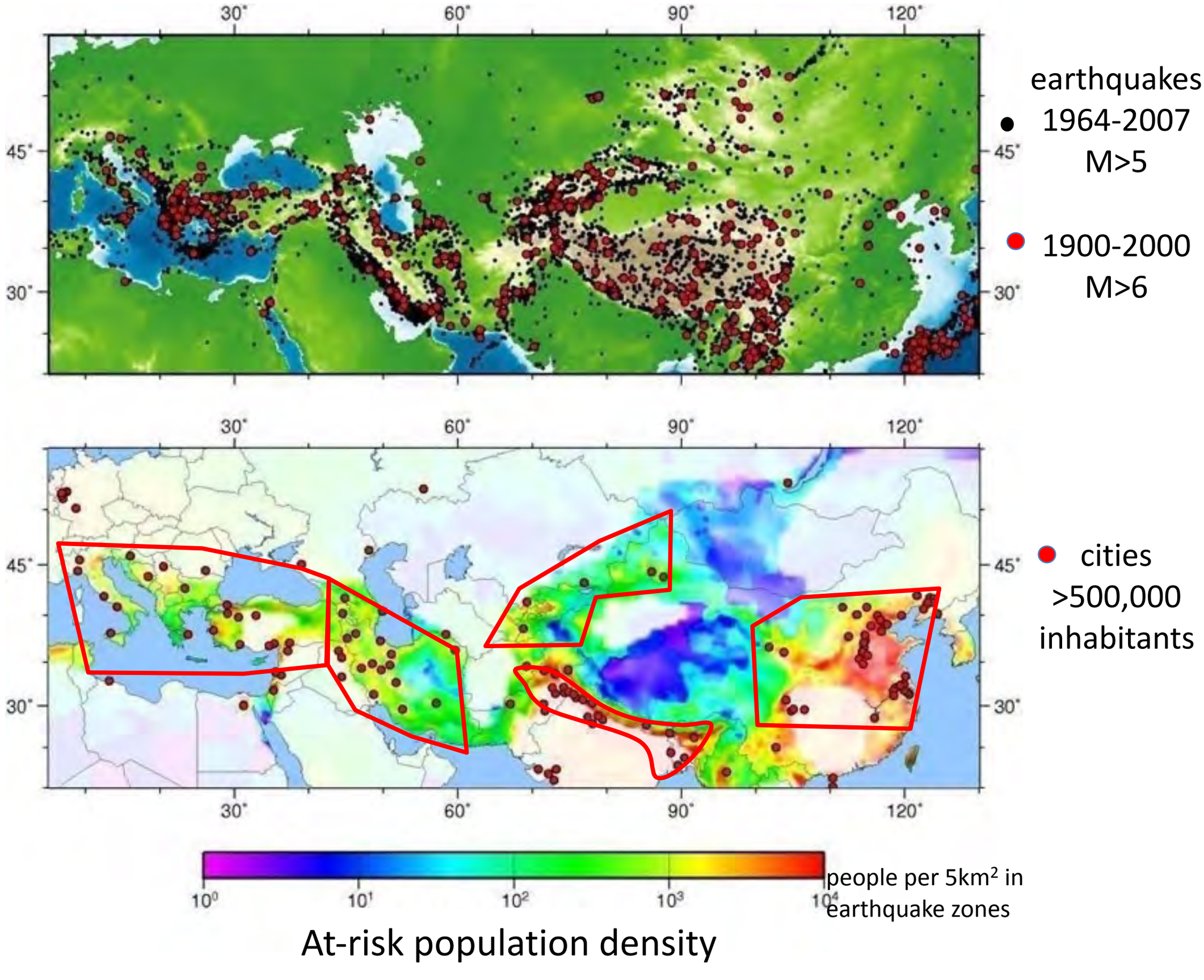
Probabilistic seismic hazard assessment

- Fault maps, recurrence intervals, likely magnitudes.
- Detailed calculations of distribution of ground shaking.
- Logic trees.
- Probability of ground acceleration exceeding a certain level, within a certain time interval.
- Appropriate building codes, appropriately enforced.
- Why not just reproduce this?

The fault was previously unidentified, and the region had been stable for hundreds,and perhaps thousands, of years.

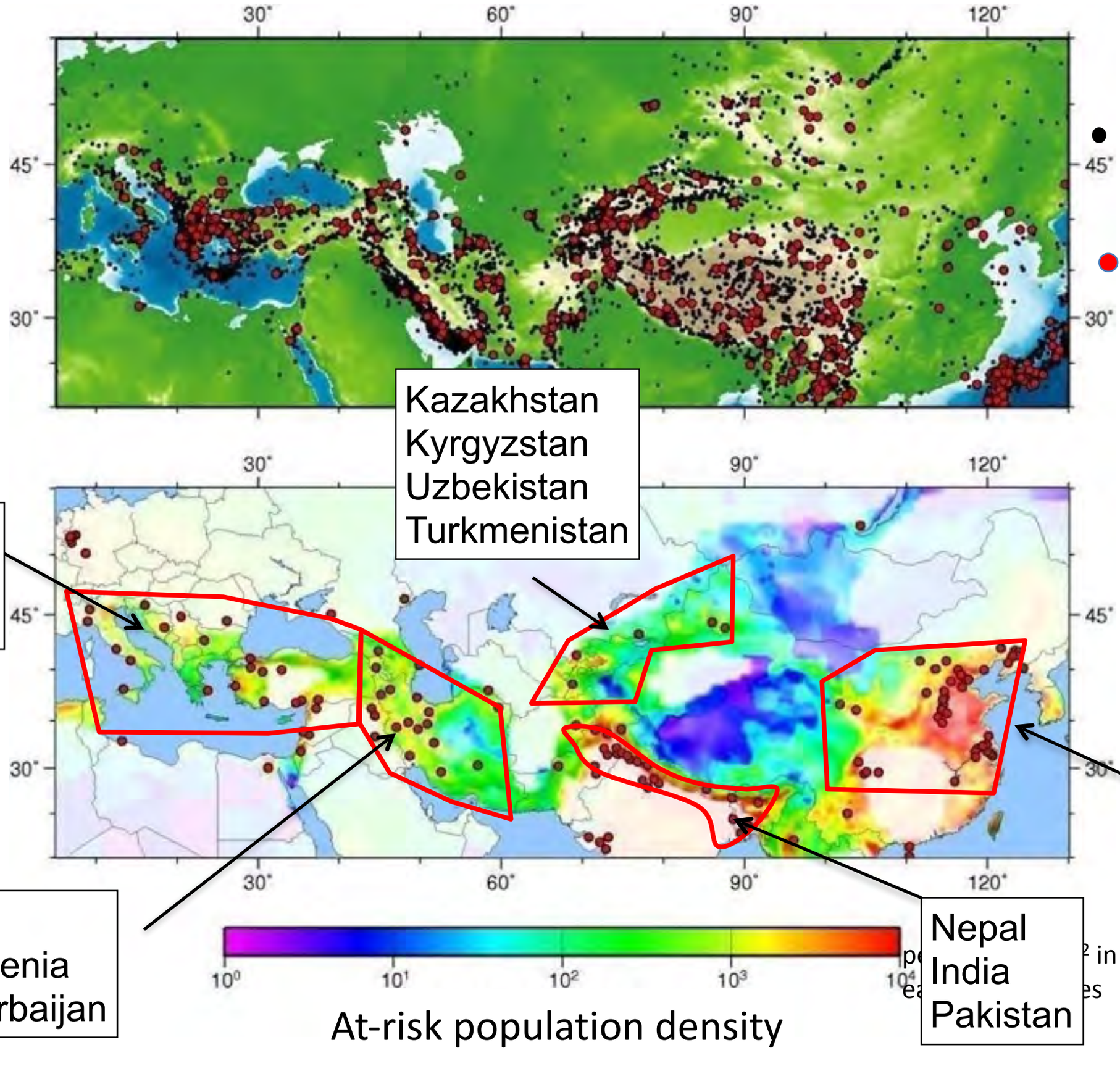

E58°35'
E58°30'
E58°25'
E58°20'
E58°15'
N29°15'
N29°10'
N29°5'
N29°
N28°55'

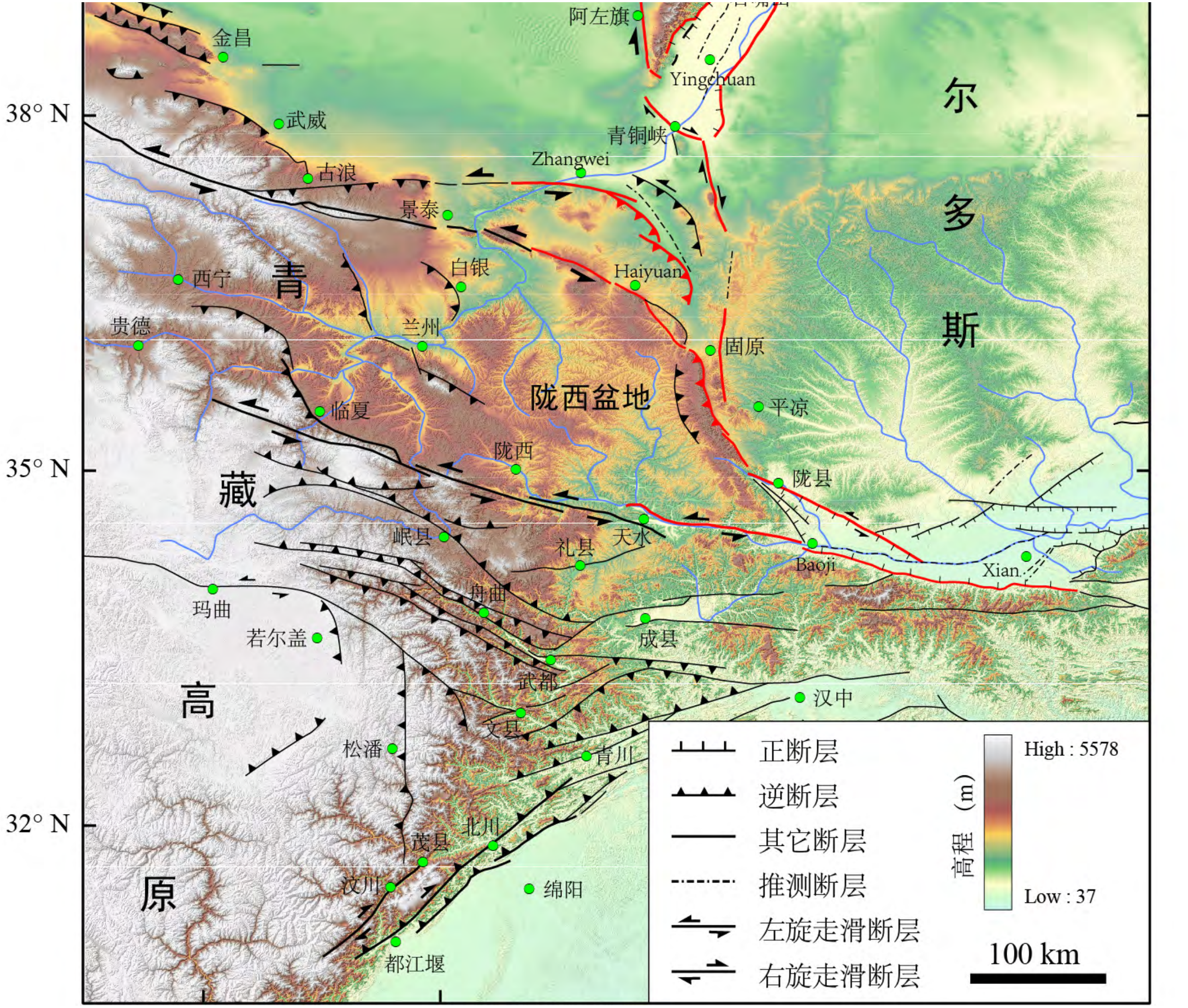
Earthquakes Without Frontiers

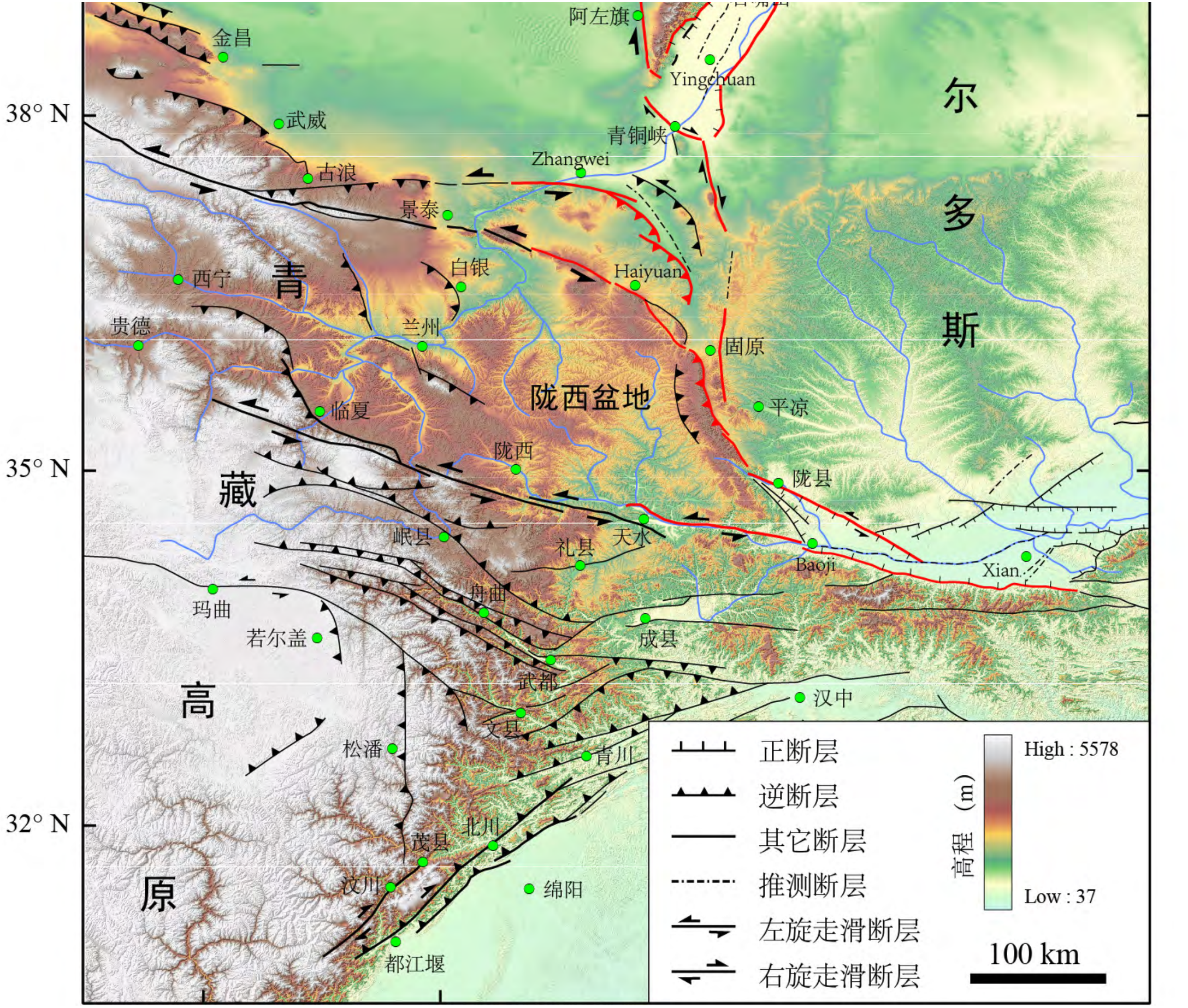


At-risk population density

Earthquakes Without Frontiers




阿左旗
金昌
Yingchuan
尔
38° N
武威
青铜峡
Zhangwei
古浪
多
景泰
白银
Haiyuan
西宁
青
斯
贵德
兰州
固原
陇西盆地
平凉
临夏
陇西
35° N
藏
陇县
岷县
礼县
天水
Baoji
Xian
舟曲
玛曲
若尔盖
成县
武都
高
汉中
文县
松潘
青川
32° N
北川
茂县
原
汶川
绵阳
都江堰
正断层
逆断层
其它断层
推测断层
左旋走滑断层
右旋走滑断层
高程（m）
High : 5578
Low : 37
100 km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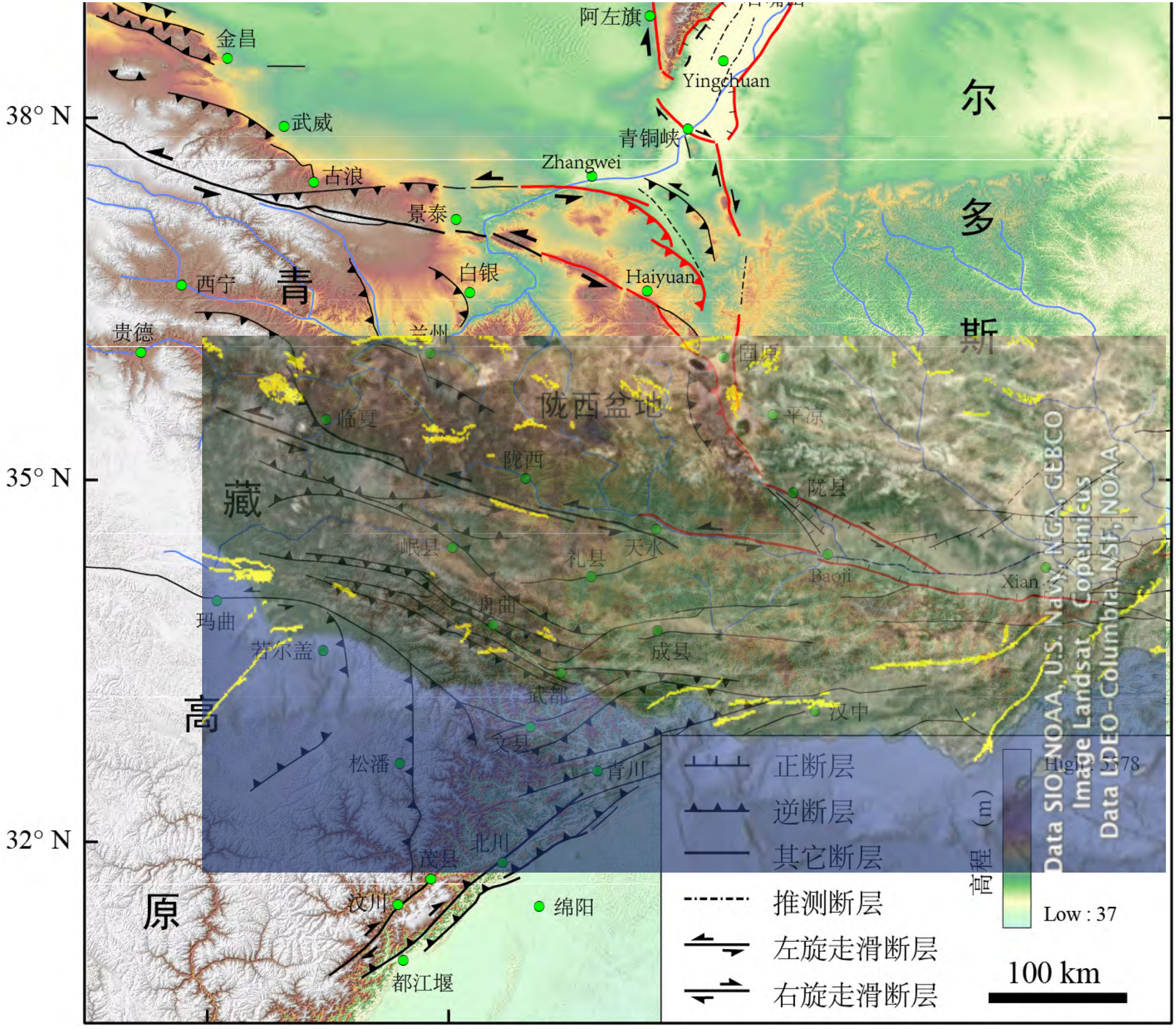
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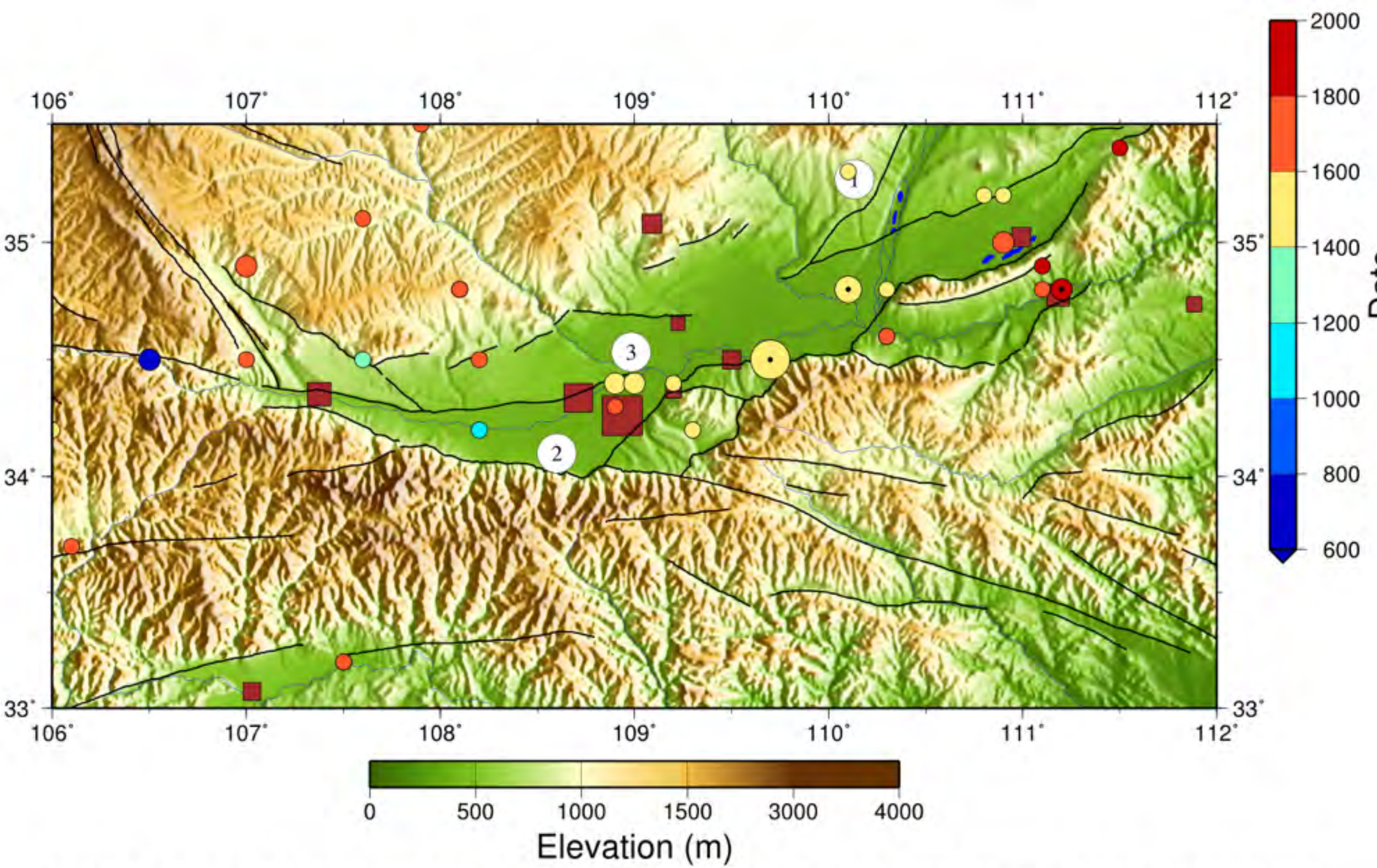
正断层
逆断层
其它断层
推测断层
左旋走滑断层
右旋走滑断层
高程（m）
High : 3578
Low : 37
100 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat, Copernicus
Data LDEO-Columbia, NSF, NOAA



Most of the historical earthquakes were on faults that have been mapped. **But** only a small fraction of those faults experienced earthquakes in the last 2000 years. **ALL** the faults are potential sites for **future** earthquakes.