Assessing hazard in inaccessible regions: the Makran subduction zone

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Earthquakes without Frontiers
NATURAL ENVIRONMENT RESEARCH COUNCIL
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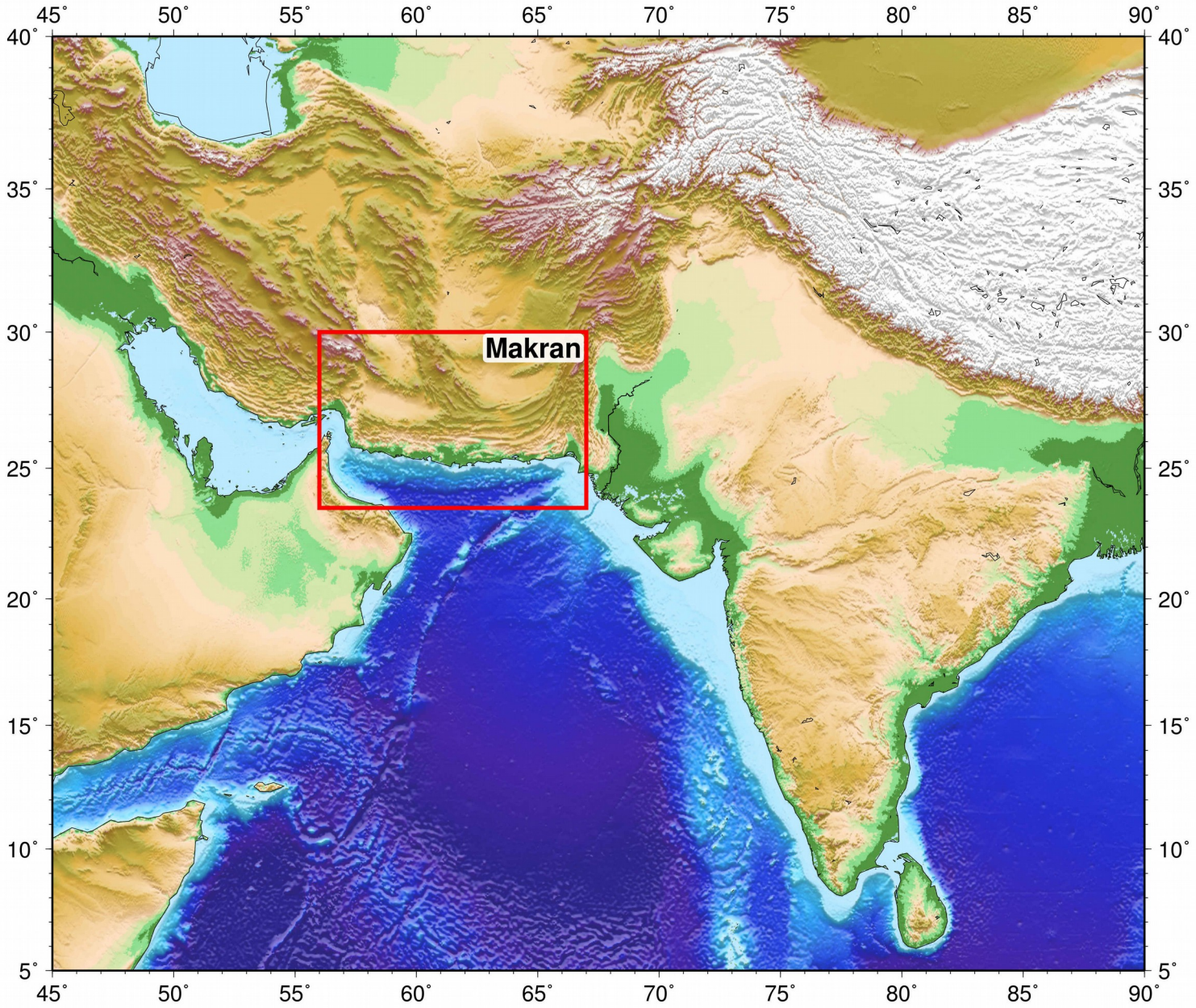
PAKISTAN METEOROLOGICAL DEPARTMENT

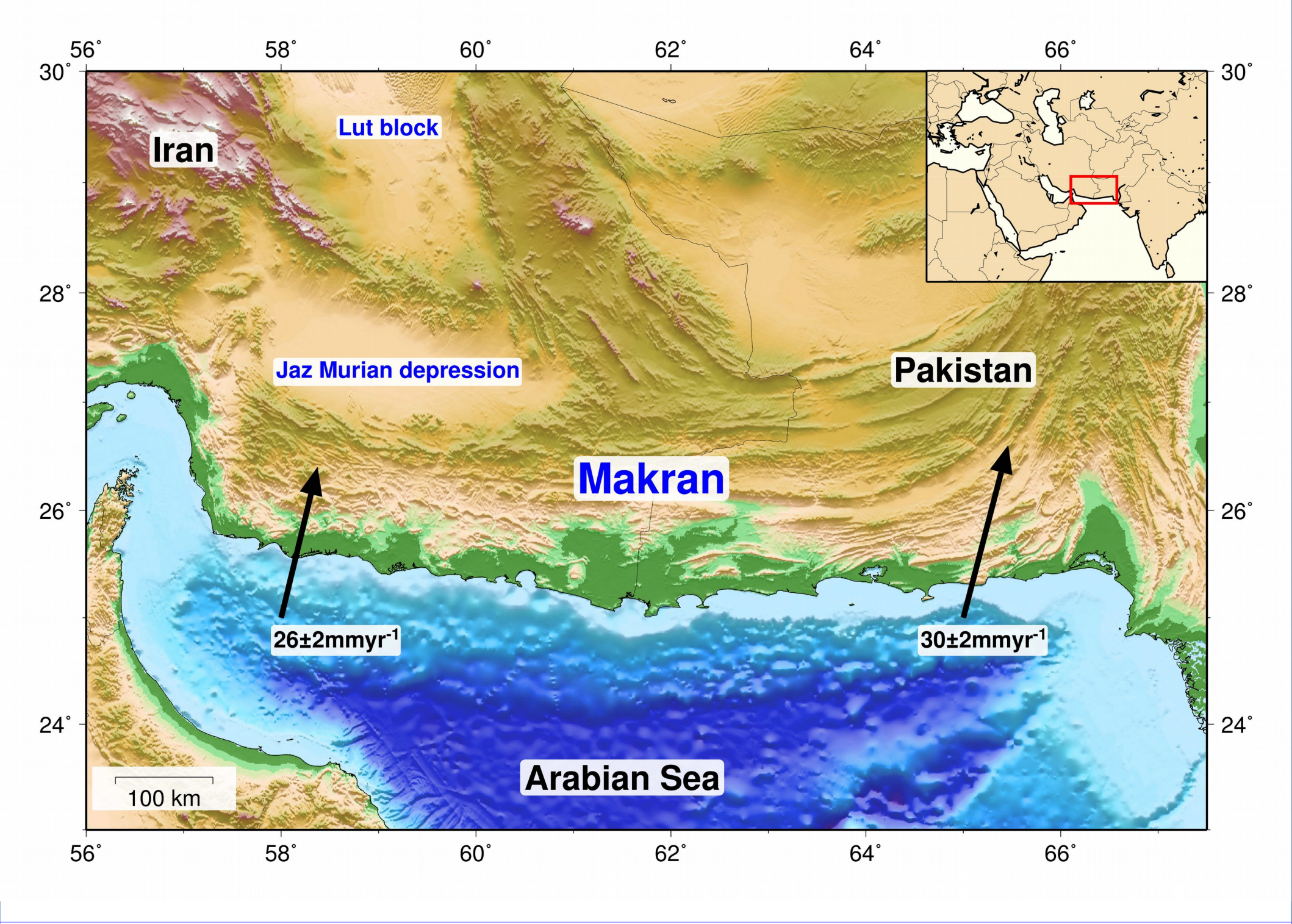
NERC SCIENCE OF THE ENVIRONMENT

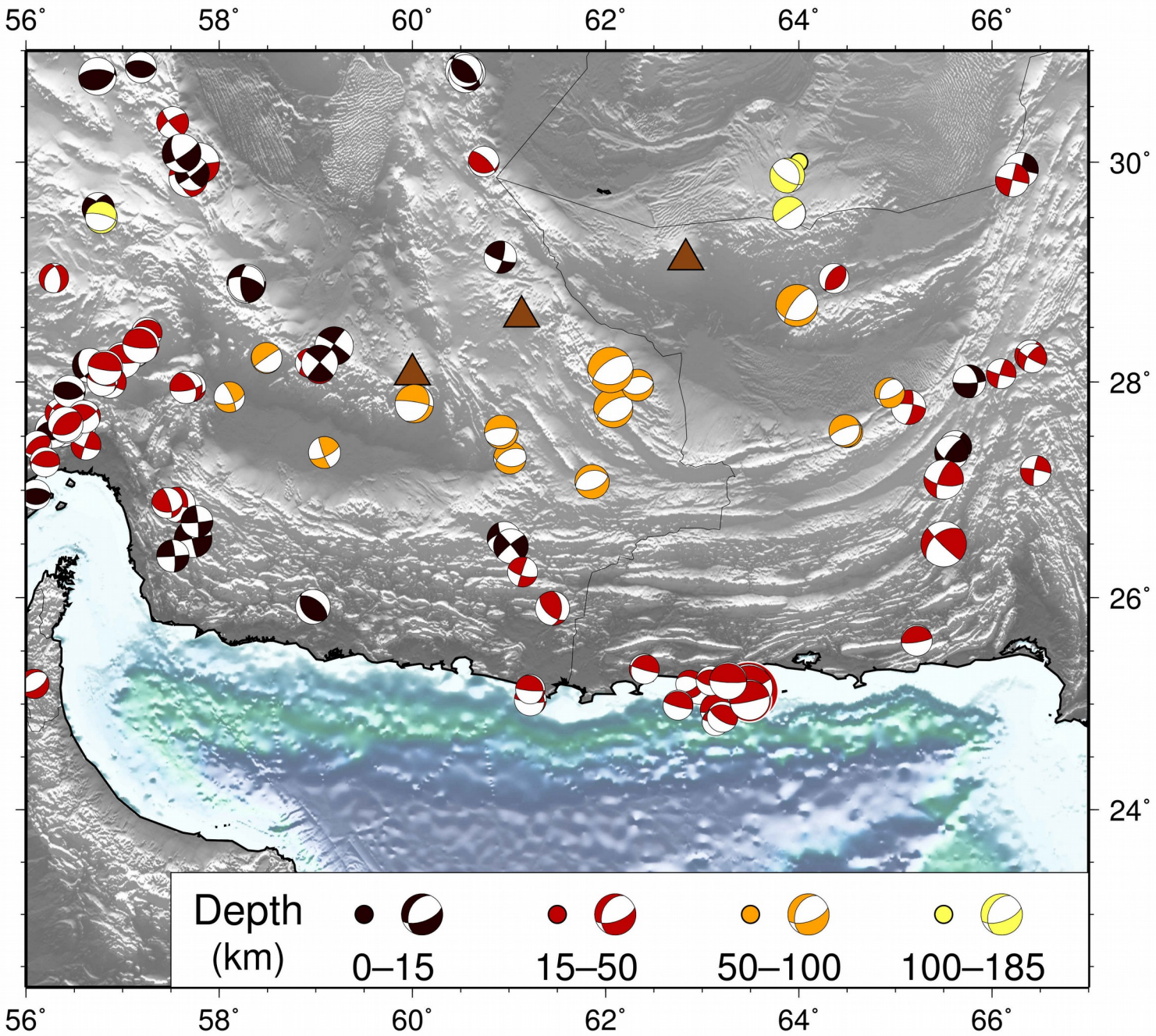
COMET

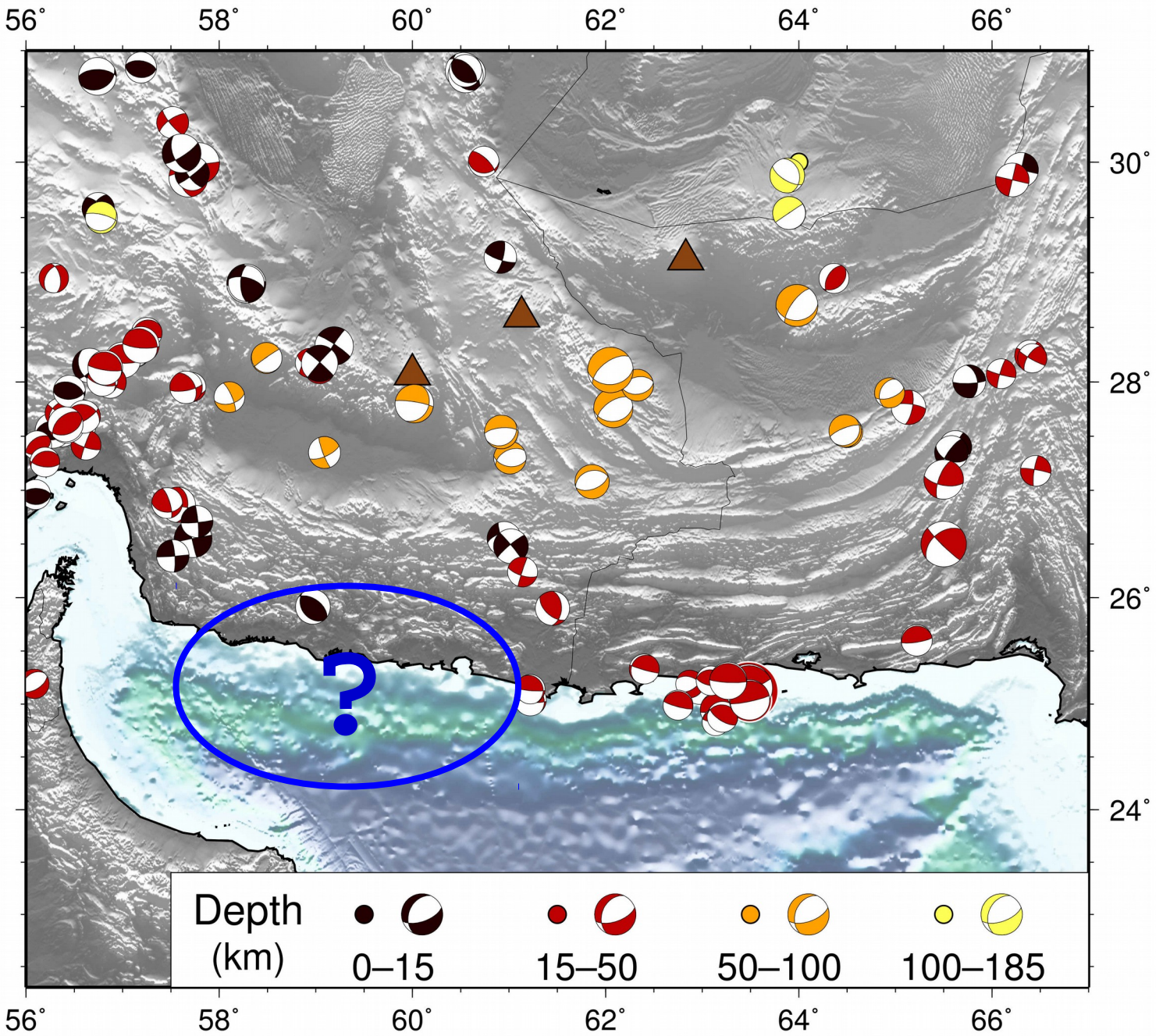
UNIVERSITY OF CAMBRIDGE

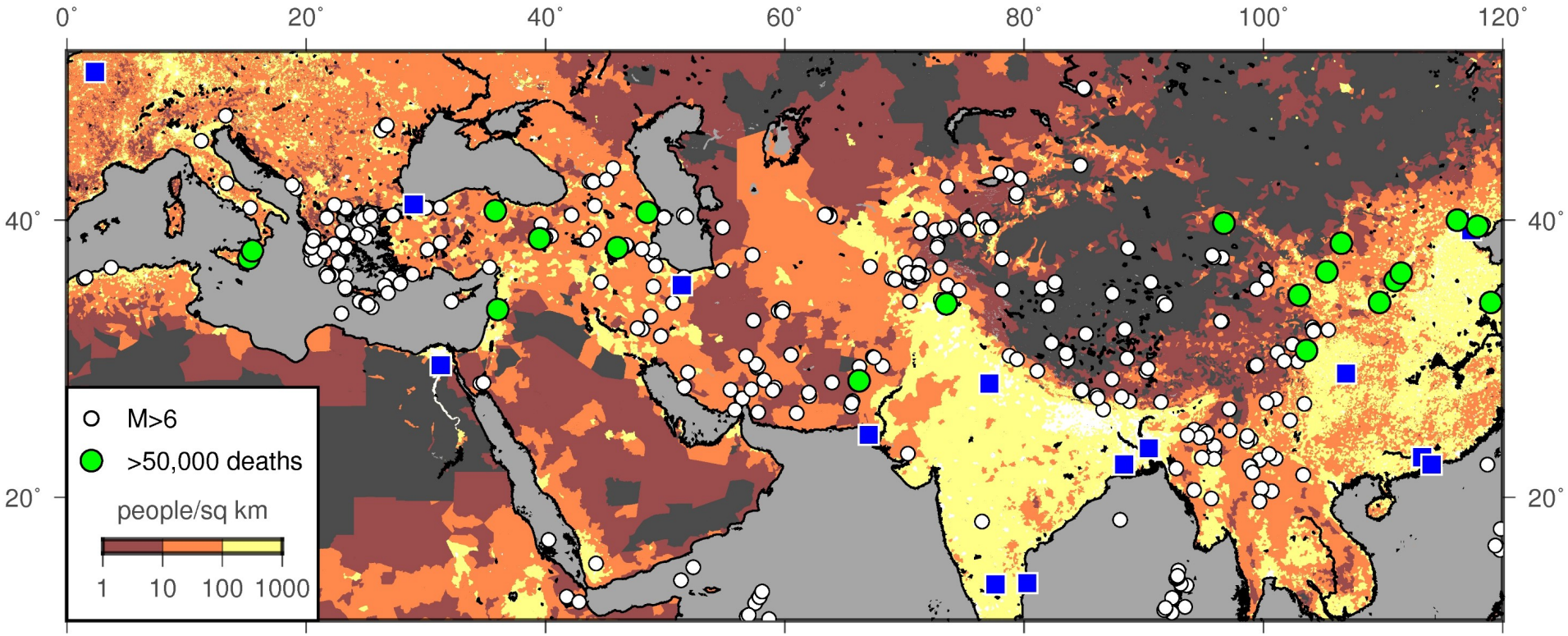
Google earth

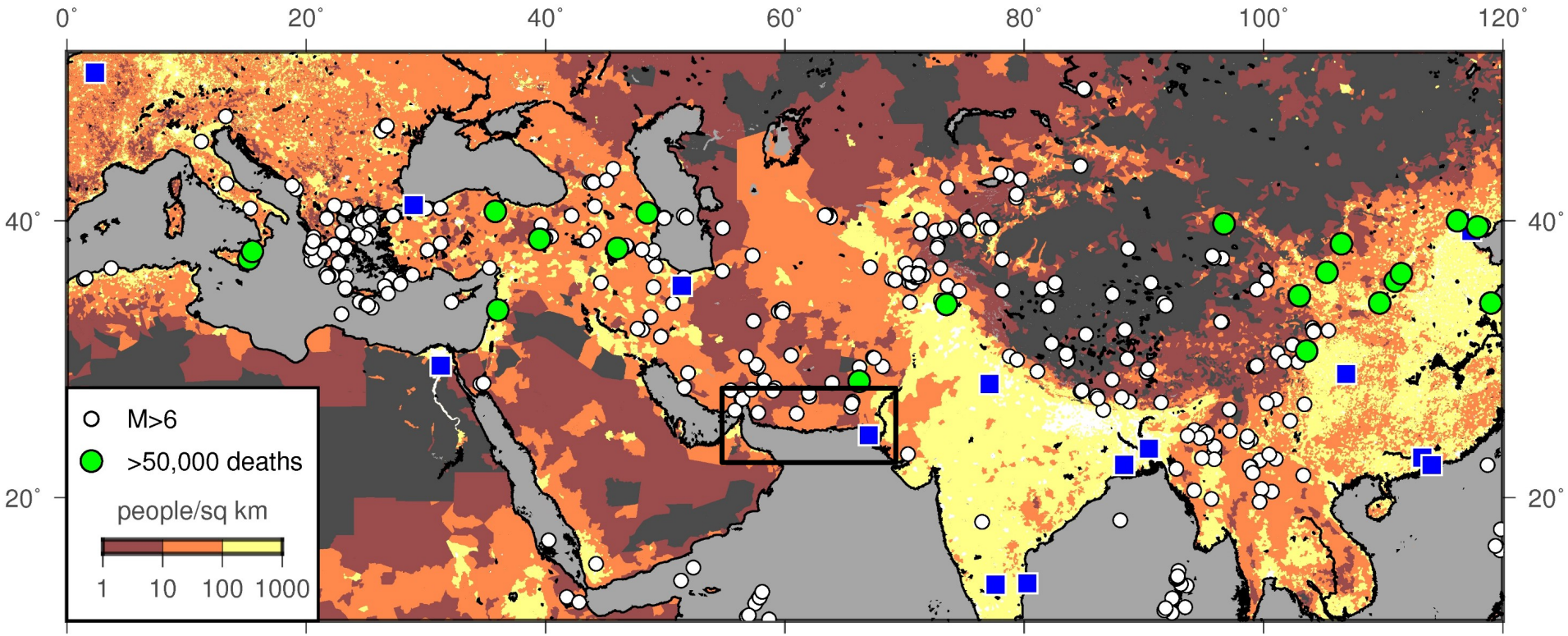

Makran
45°
50°
55°
60°
65°
70°
75°
80°
85°
90°
40°
35°
30°
25°
20°
15°
10°
5°

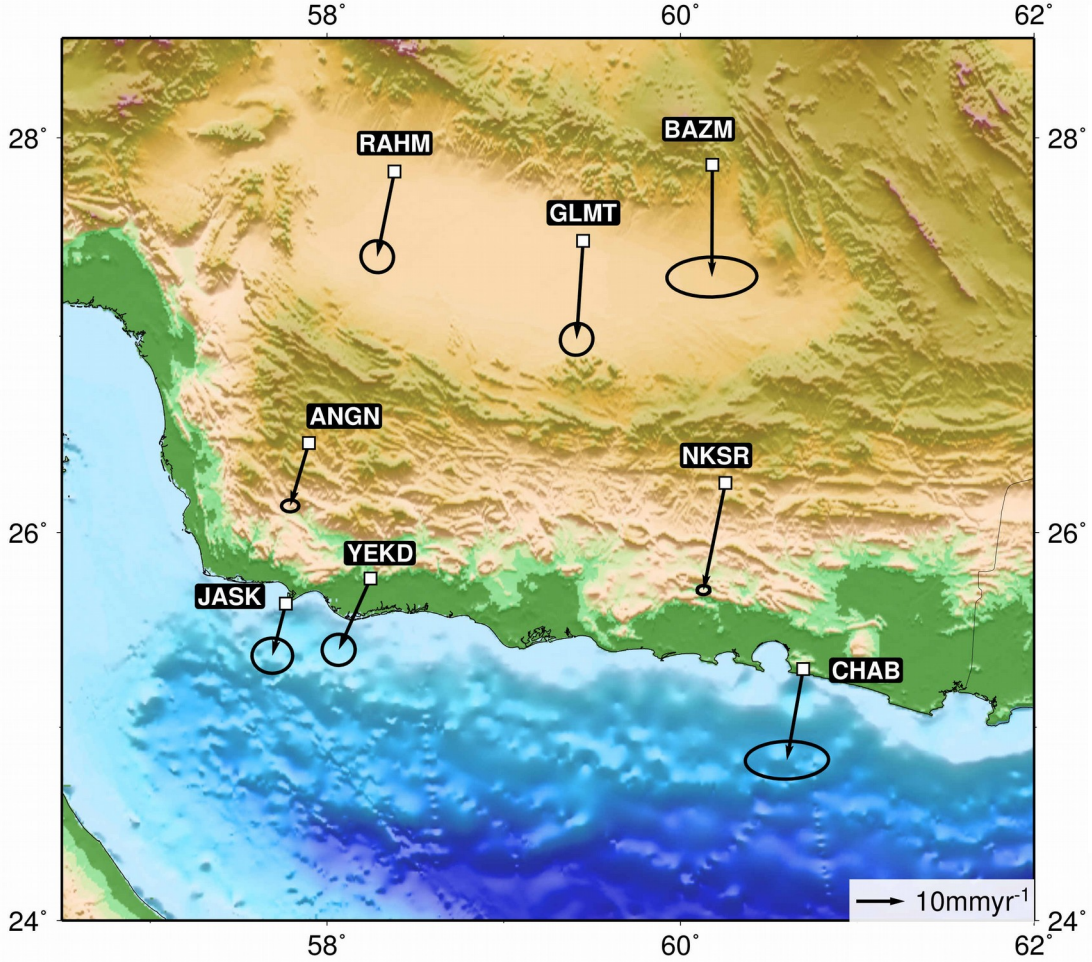

56°
58°
60°
62°
64°
66°
30°
28°
26°
24°
Iran
Lut block
Jaz Murian depression
Pakistan
Makran
26±2mmyr-1
30±2mmyr-1
Arabian Sea
100 km

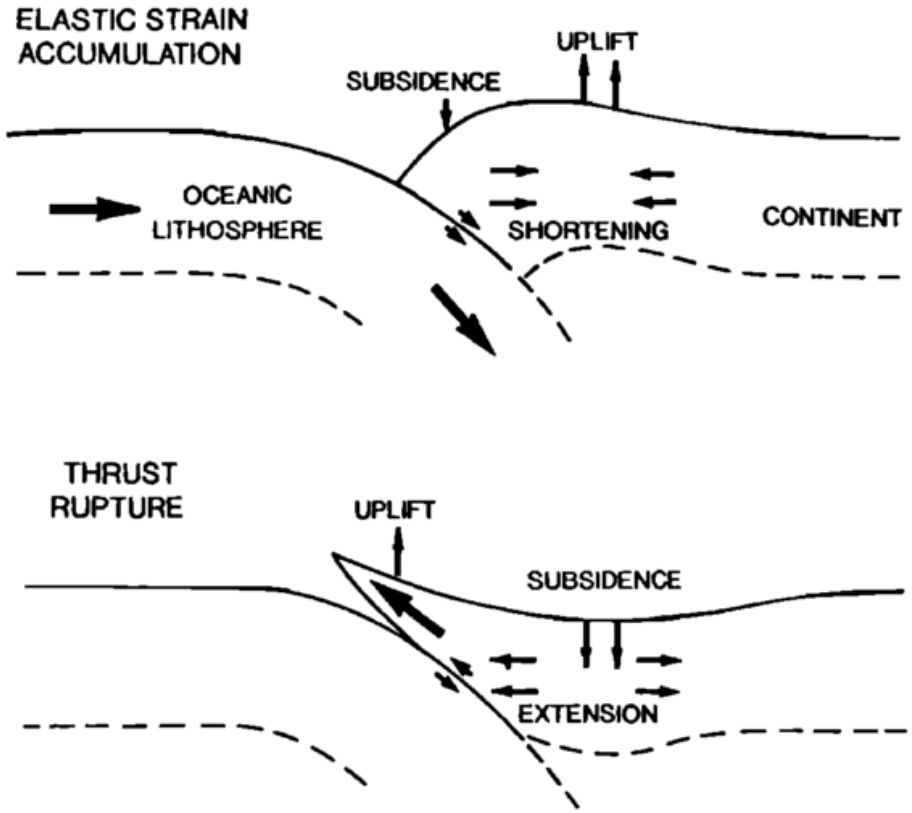

56˚
58˚
60˚
62˚
64˚
66˚
30˚
28˚
26˚
24˚
Depth
(km)
0–15
15–50
50–100
100–185


56˚
58˚
60˚
62˚
64˚
66˚
30˚
28˚
26˚
24˚
?
Depth
(km)
0–15
15–50
50–100
100–185

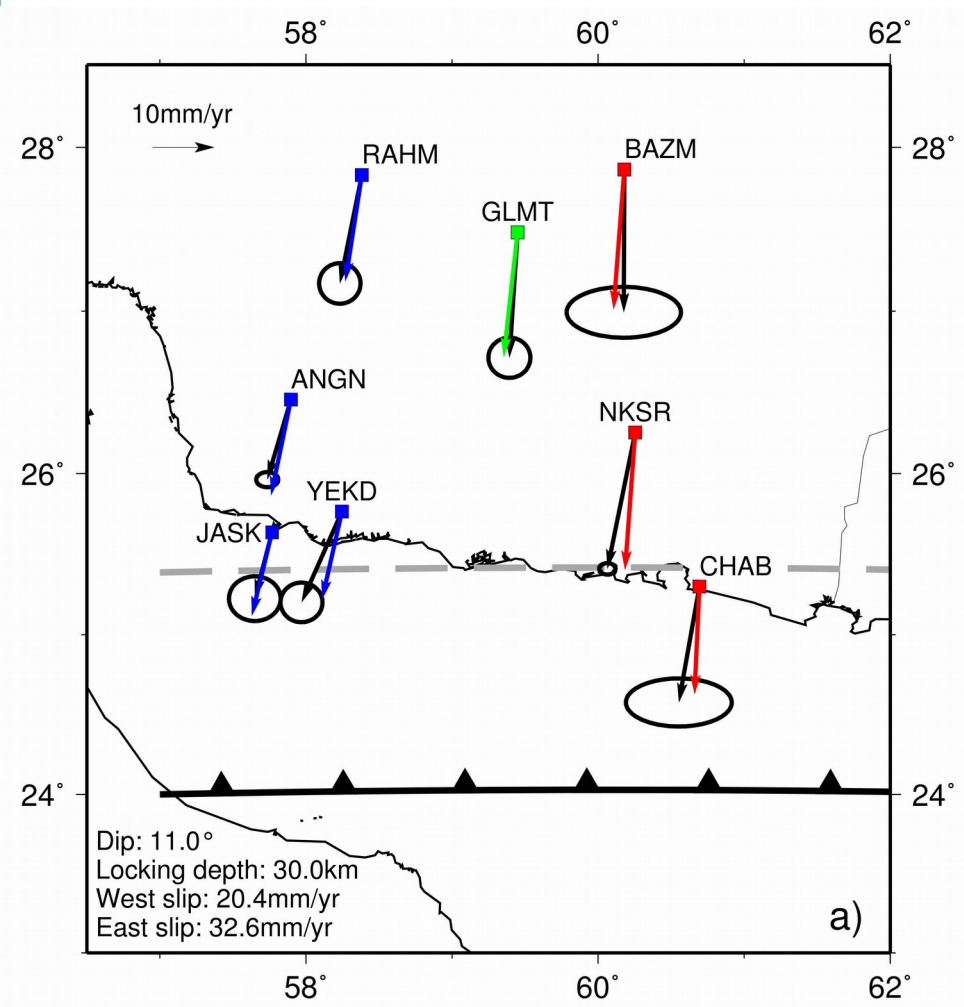

0˚
20˚
40˚
60˚
80˚
100˚
120˚
40˚
20˚
M>6
>50,000 deaths
people/sq km
1
10
100
1000

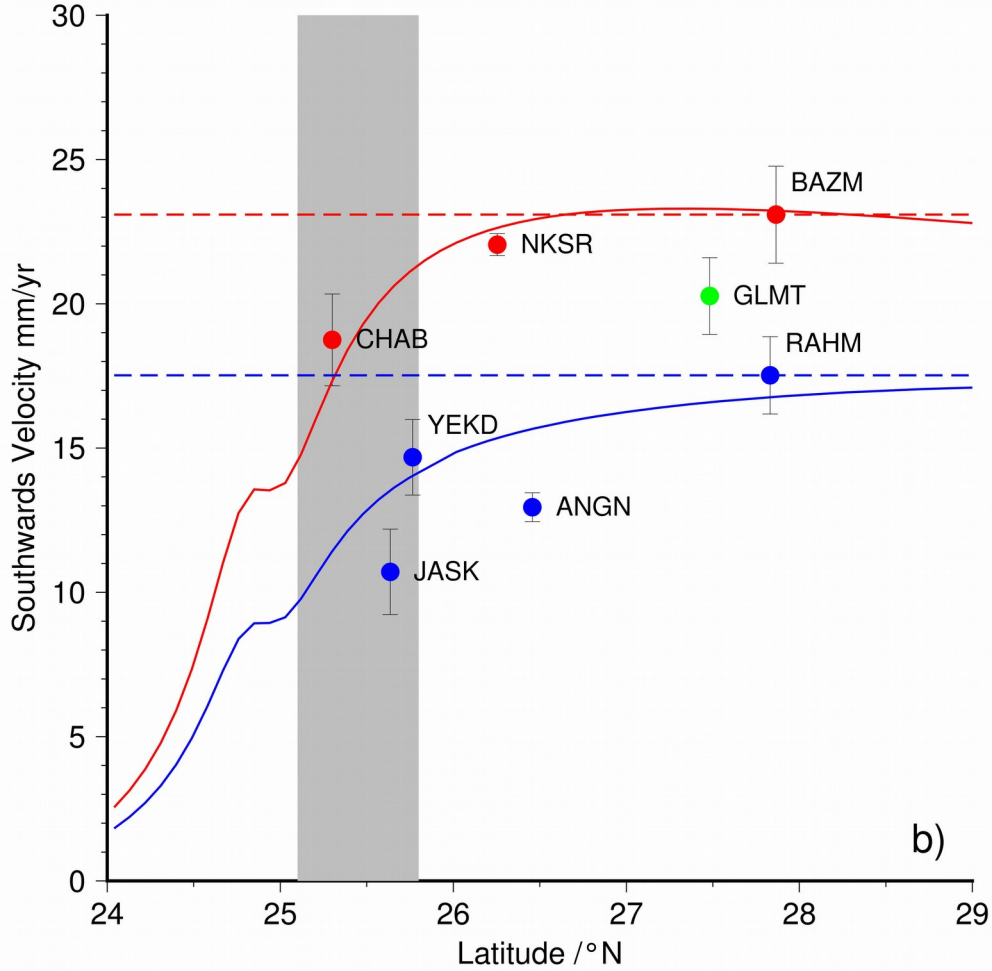

0˚
20˚
40˚
60˚
80˚
100˚
120˚
40˚
20˚
M>6
>50,000 deaths
people/sq km
1
10
100
1000

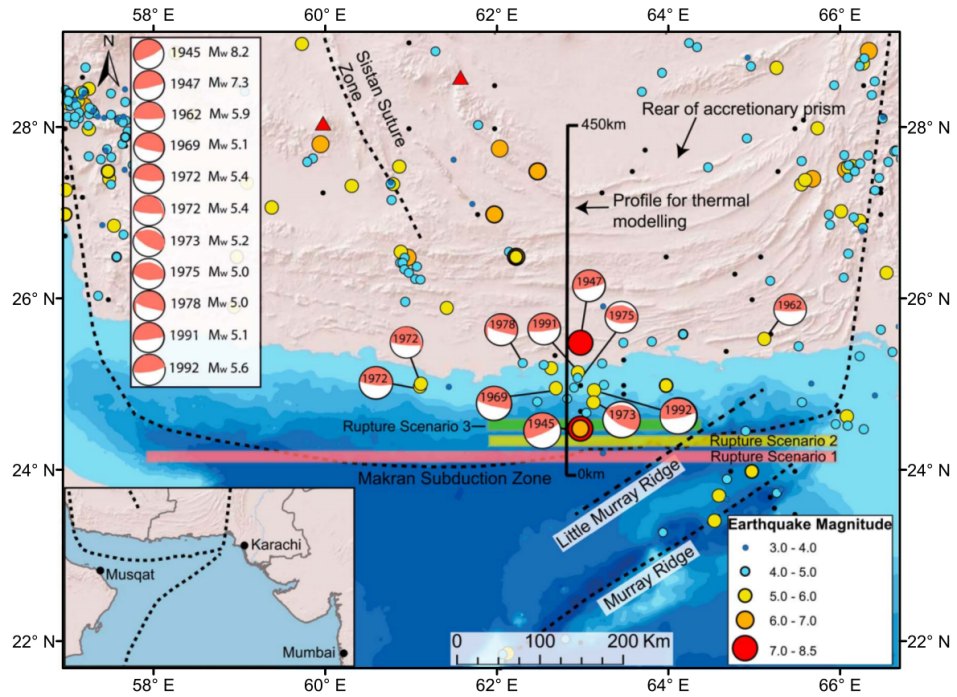




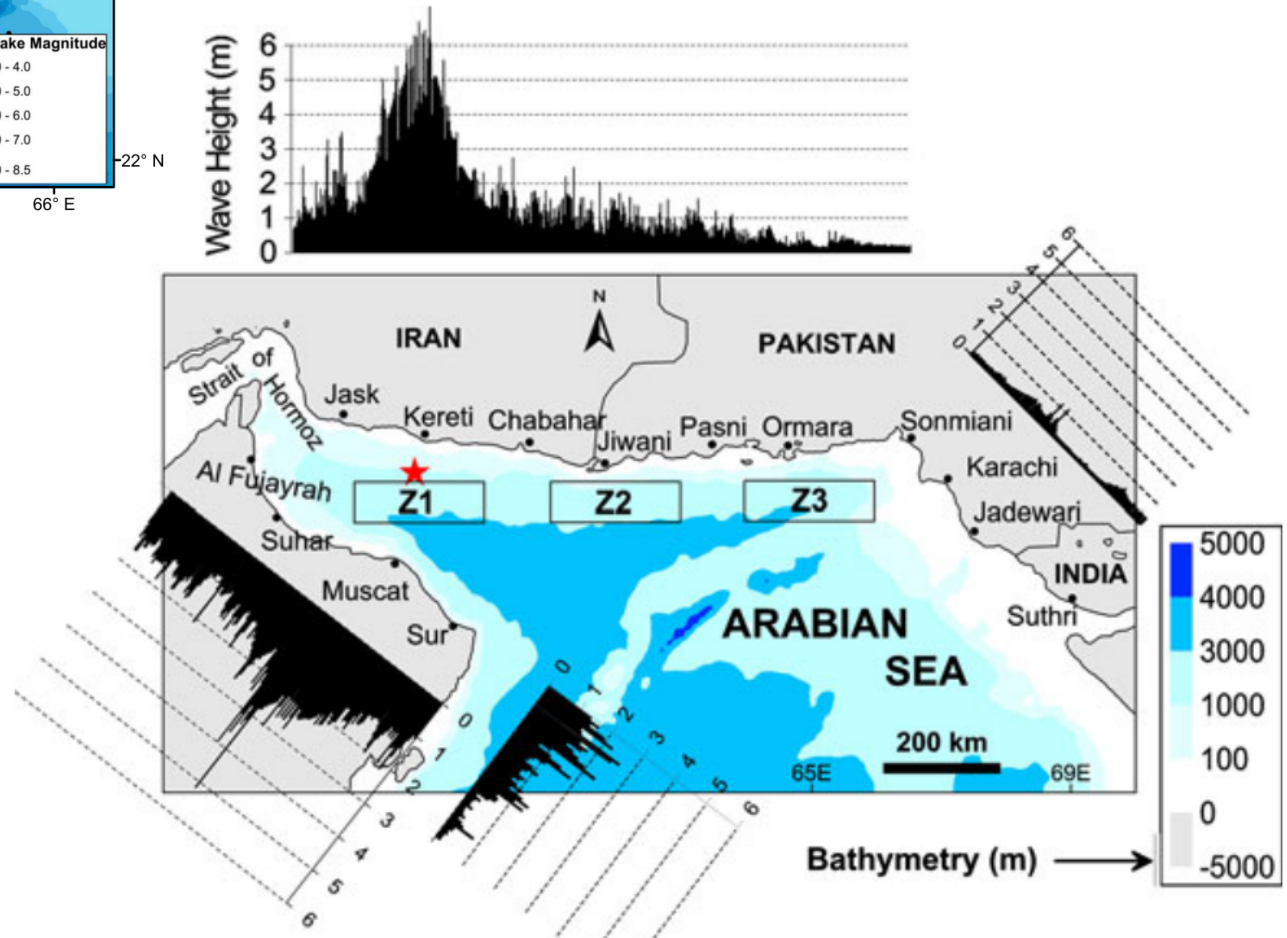
Hyndman & Wang, 1993


58˚
60˚
62˚
28˚
26˚
24˚
10mm/yr
RAHM
BAZM
GLMT
ANGN
NKSR
YEKD
JASK
CHAB
Dip: 11.0°
Locking depth: 30.0km
West slip: 20.4mm/yr
East slip: 32.6mm/yr
a)

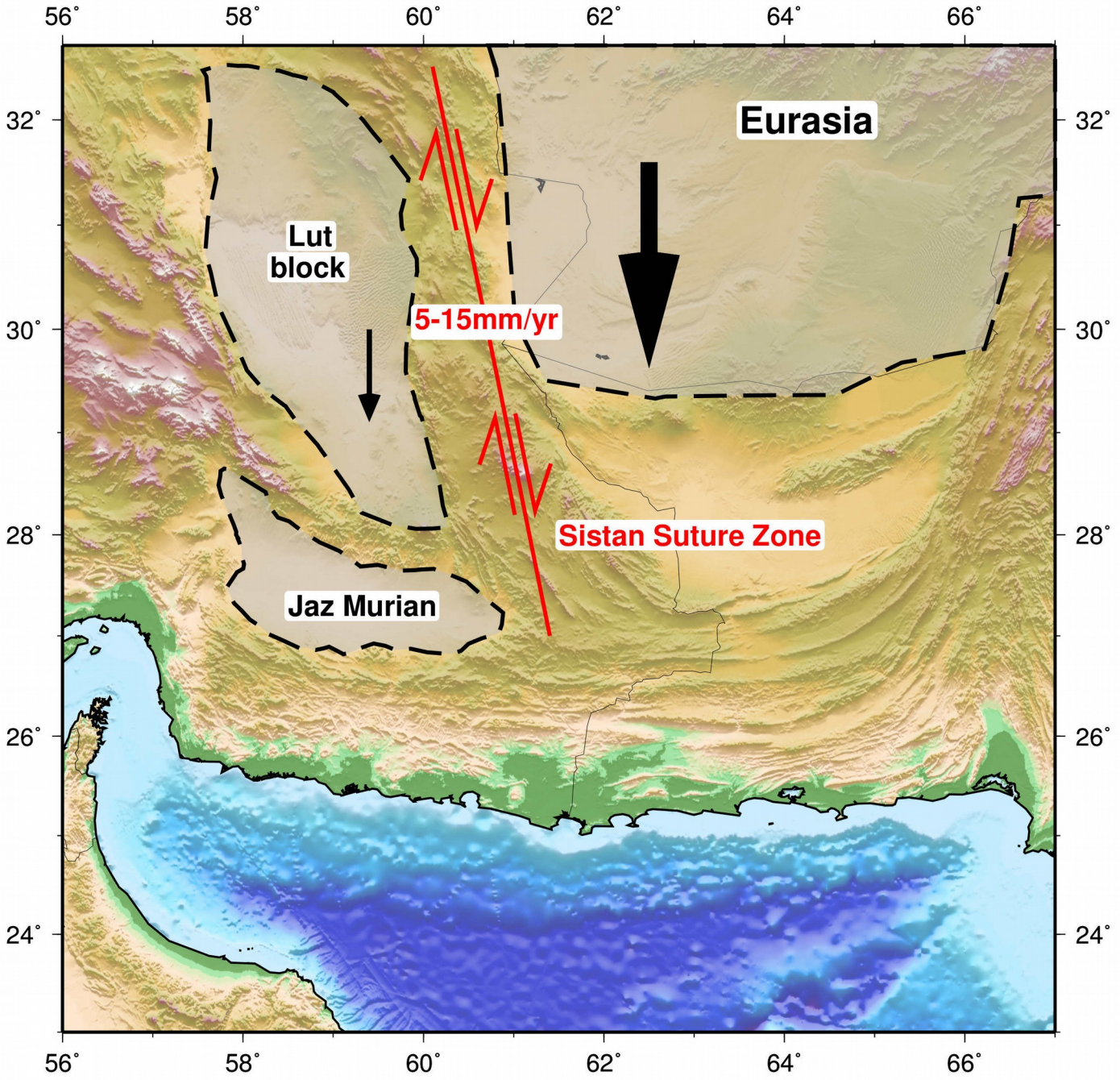

Southwards Velocity mm/yr
Latitude /°N
0
5
10
15
20
25
30
24
25
26
27
28
29
BAZM
NKSR
GLMT
RAHM
CHAB
YEKD
ANGN
JASK
b)

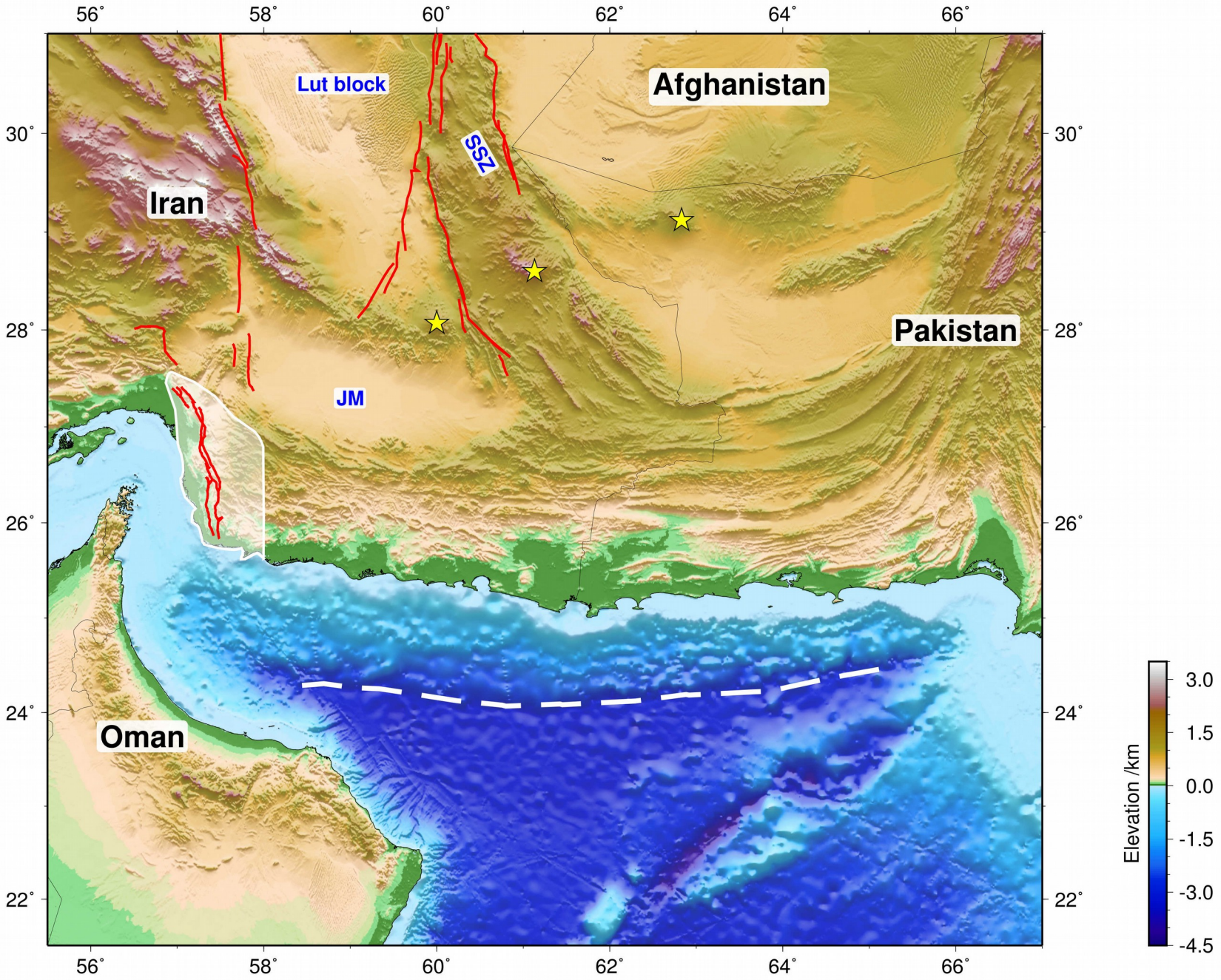


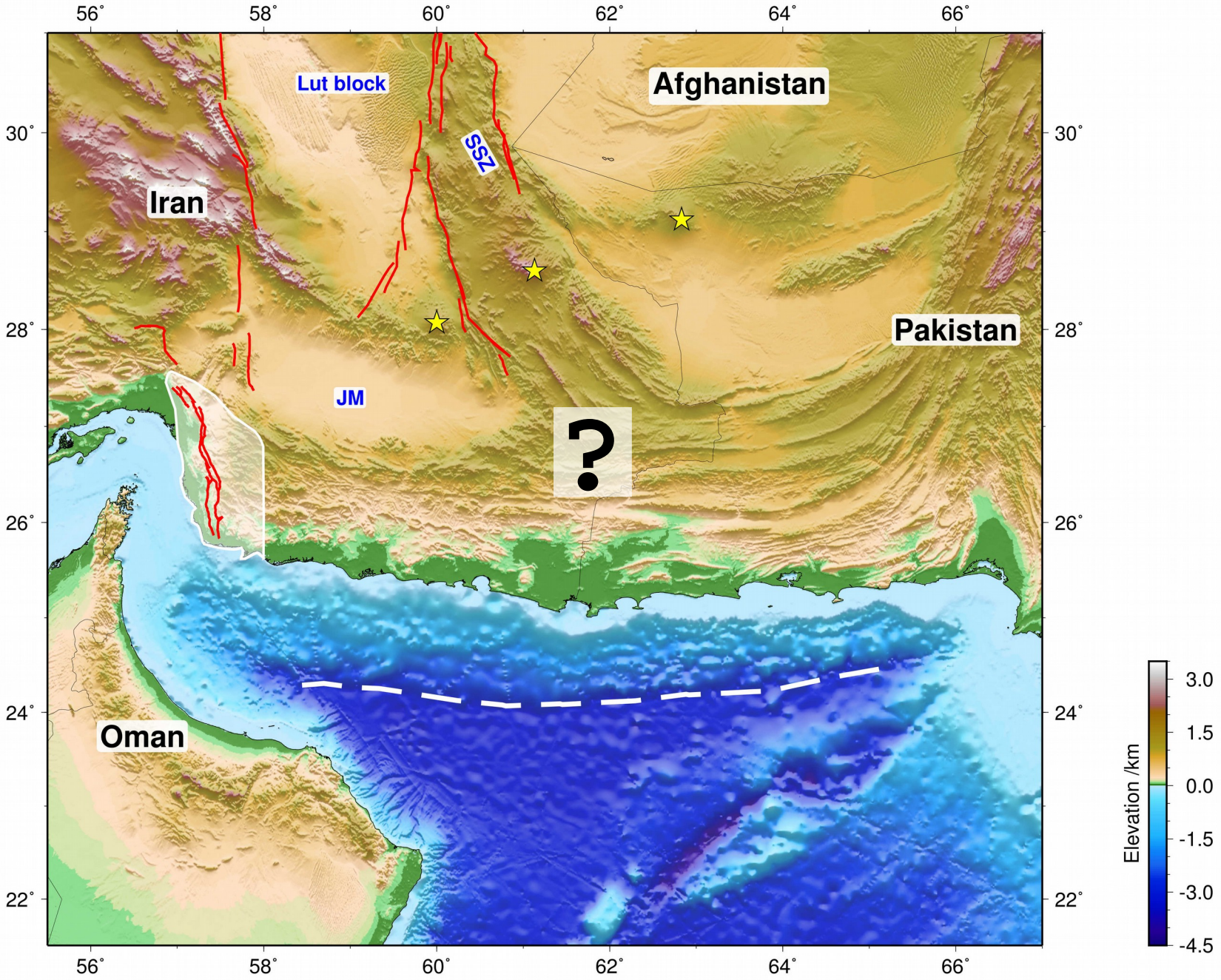
Smith et al., 2013

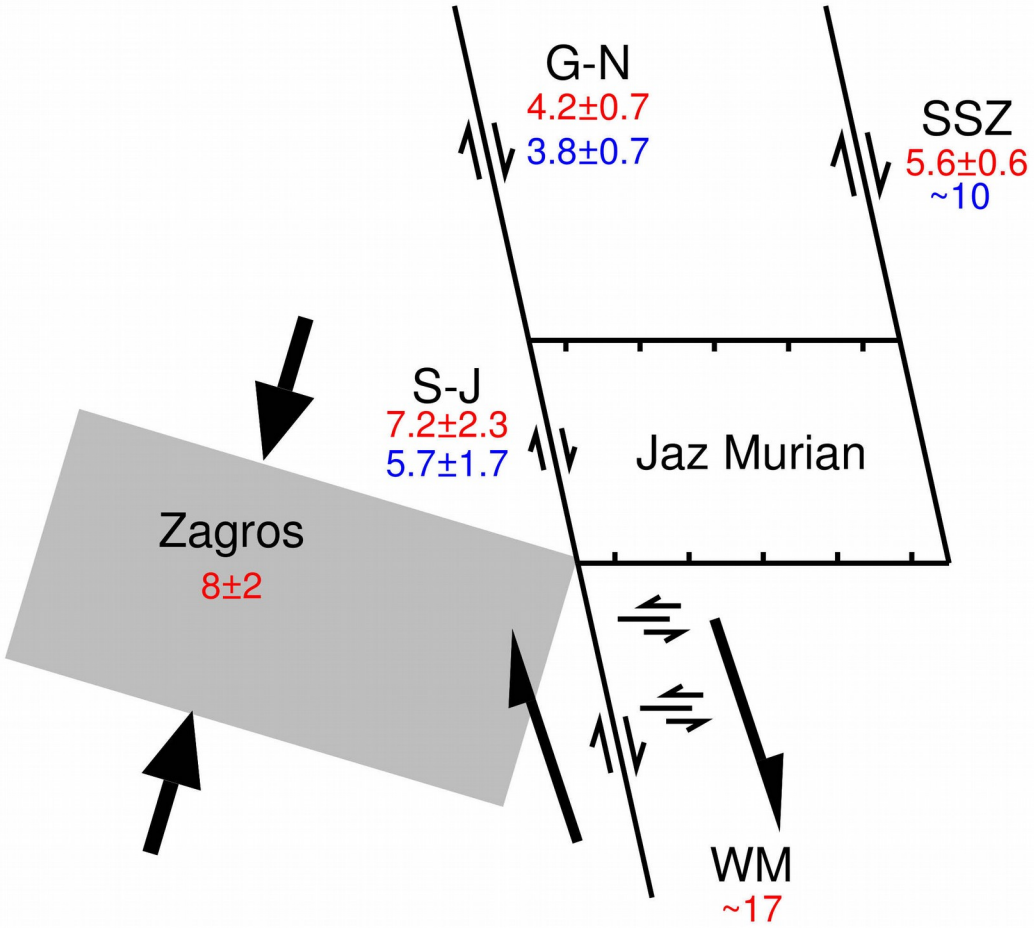


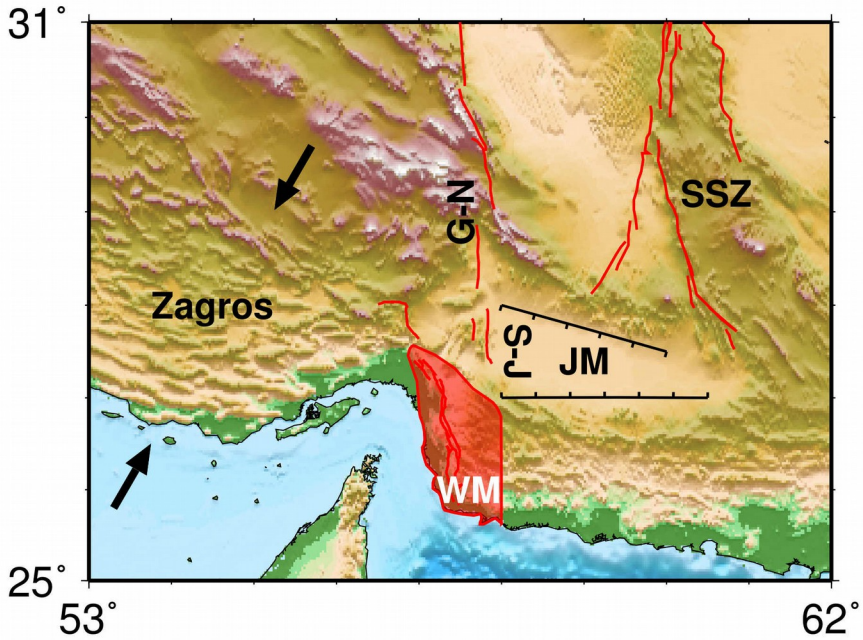
Heidarzadeh & Kijko, 2011

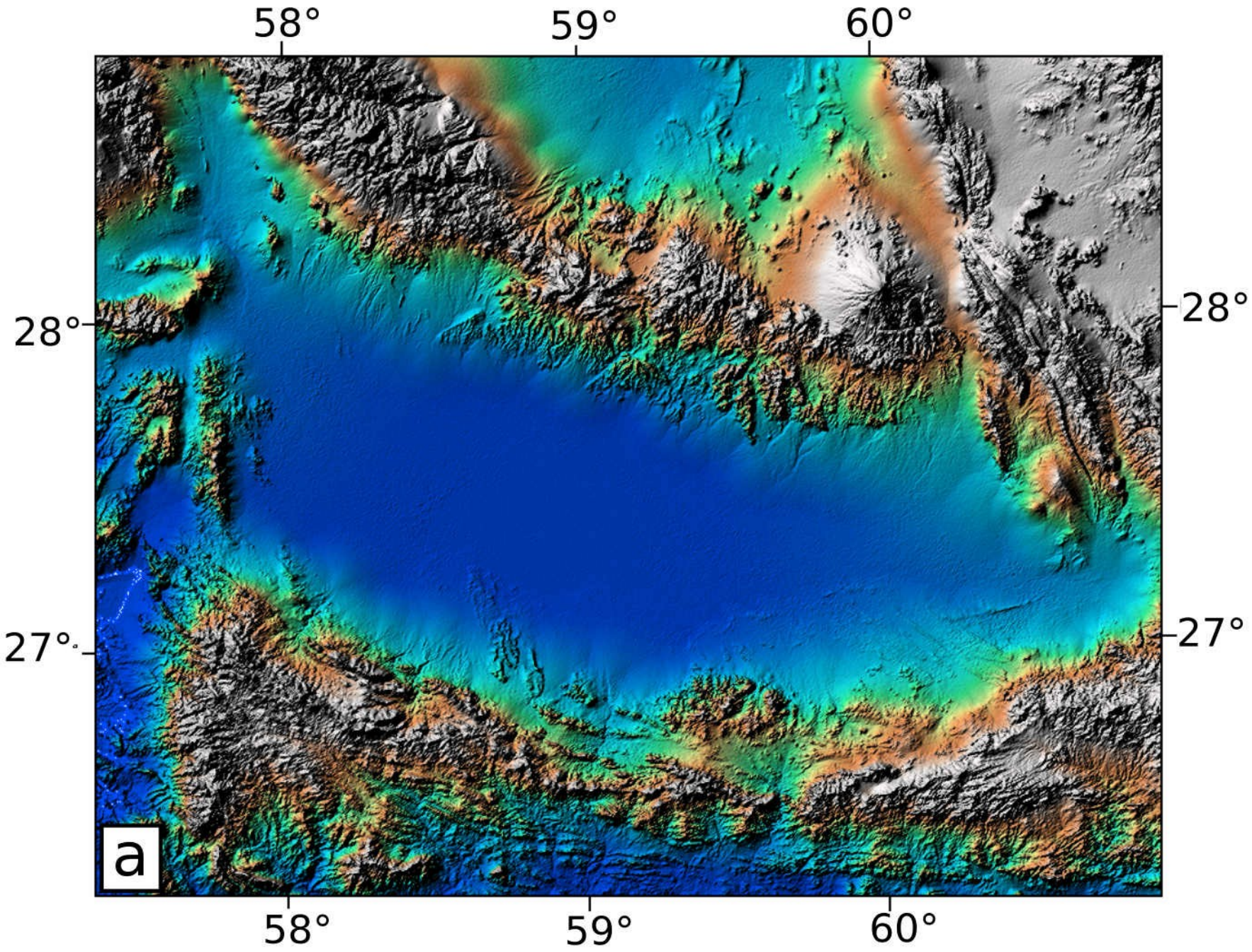

56°
58°
60°
62°
64°
66°
32°
30°
28°
26°
24°
Eurasia
Lut
block
5-15mm/yr
Sistan Suture Zone
Jaz Murian

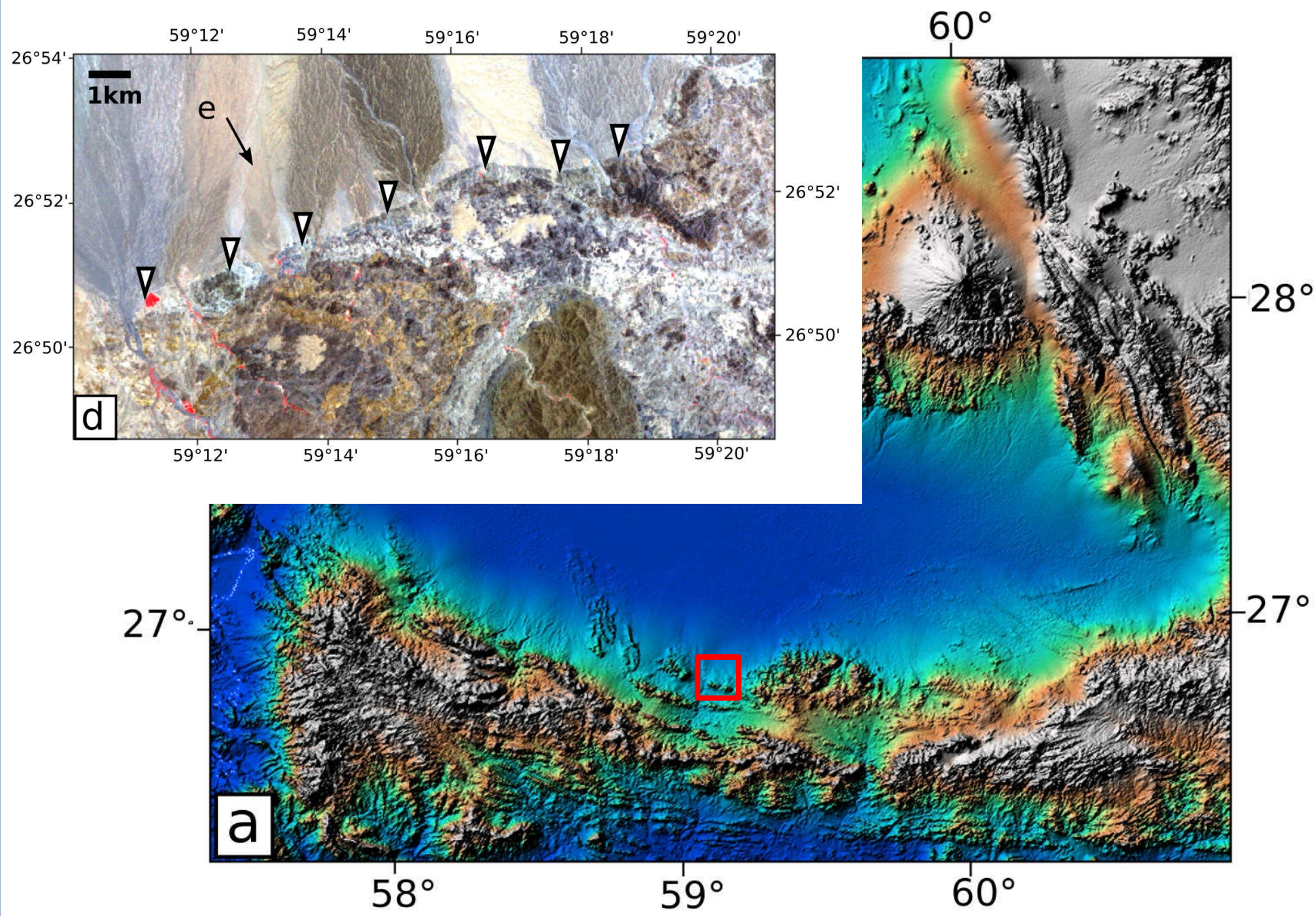

56˚
58˚
60˚
62˚
64˚
66˚
30˚
28˚
26˚
24˚
22˚
Lut block
Afghanistan
SSZ
Iran
Pakistan
JM
Oman
Elevation /km
3.0
1.5
0.0
-1.5
-3.0
-4.5

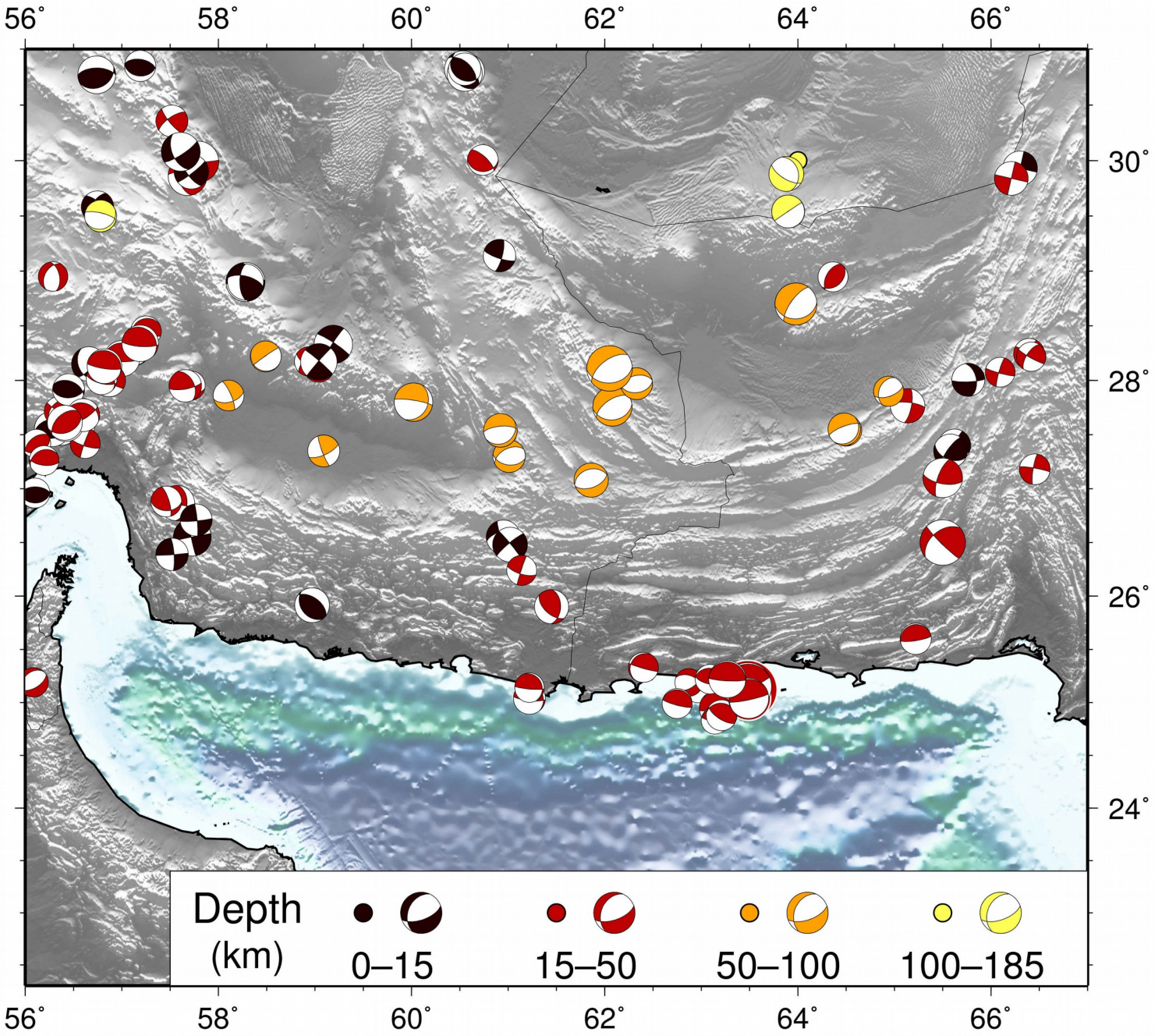

56˚
58˚
60˚
62˚
64˚
66˚
30˚
28˚
26˚
24˚
22˚
Lut block
Afghanistan
SSZ
Iran
Pakistan
JM
?
Oman
Elevation /km
3.0
1.5
0.0
-1.5
-3.0
-4.5


G-N
4.2±0.7
3.8±0.7
SSZ
5.6±0.6
~10
S-J
7.2±2.3
5.7±1.7
Jaz Murian
Zagros
8±2
WM
~17

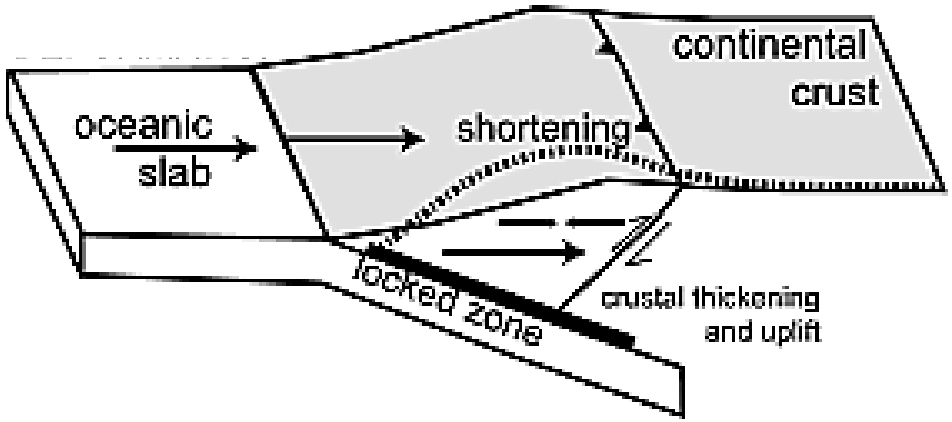

31˚
25˚
53˚
62˚
G-N
SSZ
Zagros
S-J
JM
WM


58°
59°
60°
28°
27°
a

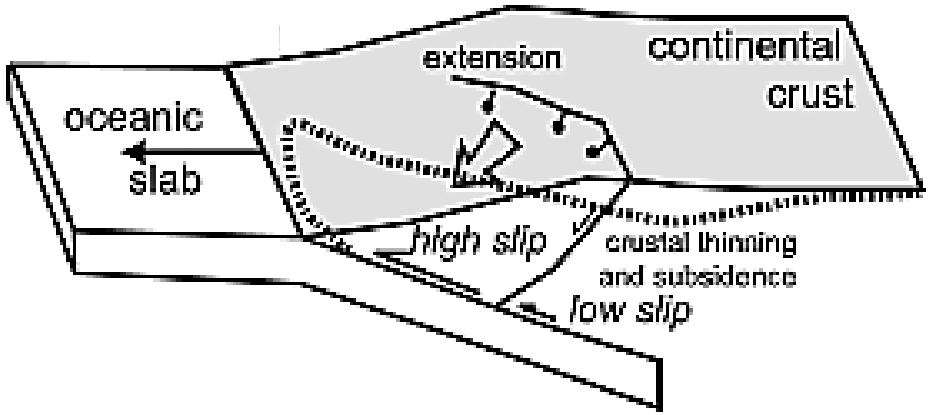

59°12'
59°14'
59°16'
59°18'
59°20'
26°54'
26°52'
26°50'
1km
e
d
60°
28°
27°
58°
59°
a


56˚
58˚
60˚
62˚
64˚
66˚
30˚
28˚
26˚
24˚
Depth
(km)
0–15
15–50
50–100
100–185

Before a megathrust earthquake:



After a megathrust earthquake:



Farías et al., 2011

Conclusions

- The western (Iranian) Makran megathrust is building up strain, not sliding freely.
- This means that the Makran subduction zone may be able to produce a Mw 9 earthquake (and associated tsunami).
- Such an earthquake could trigger further onshore earthquakes.
- Hazard assessment in difficult-to-access locations requires a multi-disciplinary approach.

For more details see: Penney et al., 2017, Megathrust and accretionary wedge properties and behaviour in the Makran subduction zone, *GJI*