SKS splitting observations across the Iranian plateau and Zagros: the role of lithosphere deformation and mantle flow

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Introduction

- 253 broad-band stations
- More than one decade of waveform data
- Splitting analysis of 7877 core-refracted shear wave (SKS, SKKS and PKS) phases
- Joint analysis of all SKS waveforms at each station

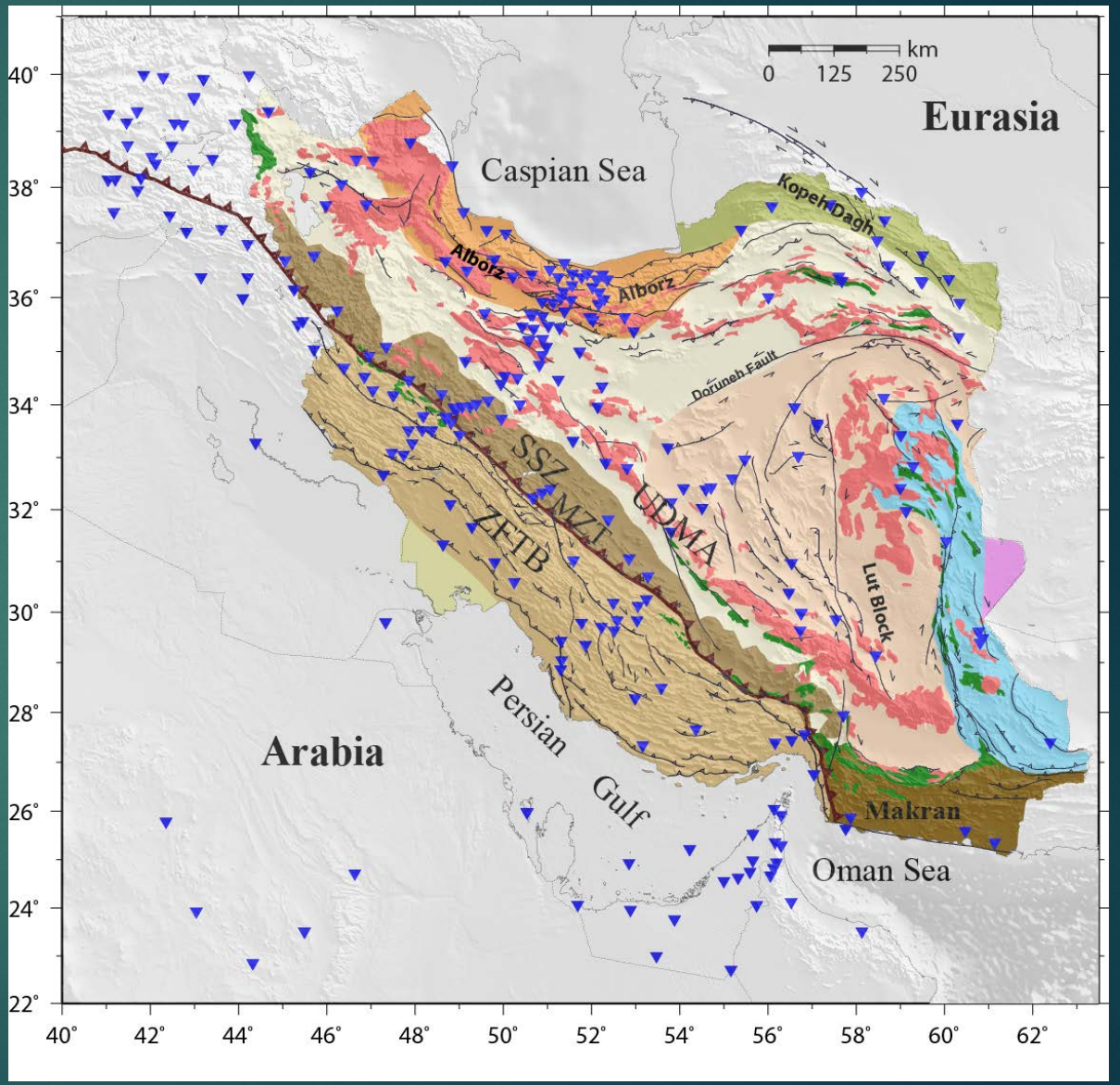

Figure 1 Geological map and seismic stations. ZFTB: Zagros folded-and-thrust belt. SSZ: Sanandaj-Sirjan metamorphic zone. UDMA: Urumieh-Dokhtar magmatic assemblage. MZT: Main Zagros Thrust. Blue inverted triangles indicate the location of seismic stations used in this study.

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Results

- A relatively uniform NE-SW oriented azimuthal anisotropy in the Arabian Plate, eastern Turkey and part of the Zagros.
- A more complex pattern across the Iranian Plateau.
- Gradual change in the direction of anisotropy from a dominantly NE-SW trend in the Zagros to a dominantly NW-SE trend along a narrow band extending from NW to SE Iran.

1) Azimuthal correlation between the plate motion direction and azimuthal anisotropy in the Arabian Plate, eastern Turkey and the western Zagros: A large-scale viscous flow in the asthenosphere

2) The spatial variation in the pattern of azimuthal anisotropy across the Iranian Plateau: A lateral change in the mantle flow and a more complex deformation history.

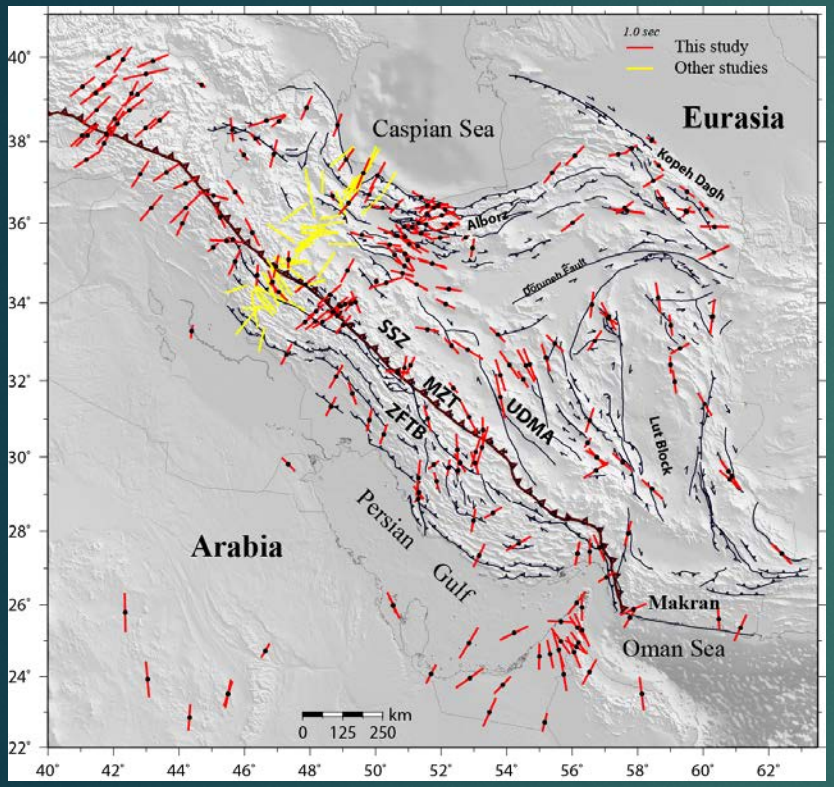


Figure 2: The average splitting parameters at each station (red bars). The yellow bars present the results from previous studies. Each bar is oriented along the fast direction and its length is proportional to the amount of split time.

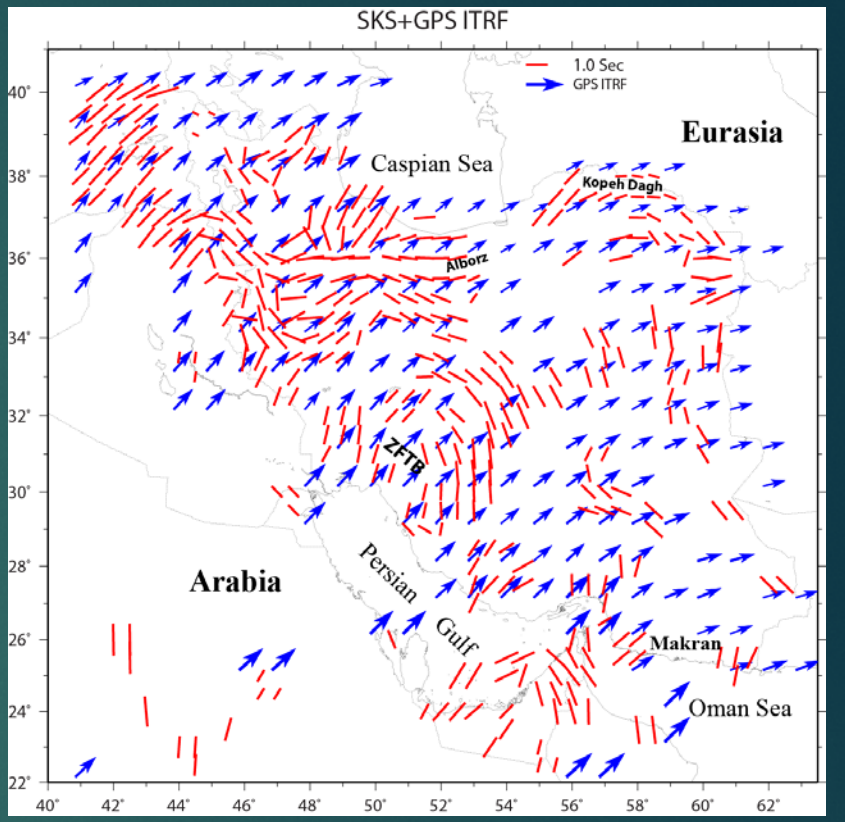


Figure 3: The interpolated anisotropy vector field at a depth of 150 km as calculated by averaging the splitting parameters at individual stations.
The absolute plate motion in an IRTF reference frame (blue arrows) are also shown for comparison.

Lithospheric deformation and/or asthenospheric flow?

Some degree of correlation between extensional strain at the surface and fast anisotropy directions in the central Alborz and Kopeh-Dagh (pure shear in the lithosphere). Axial shortening in the Zagros with vertical maximum strain axis

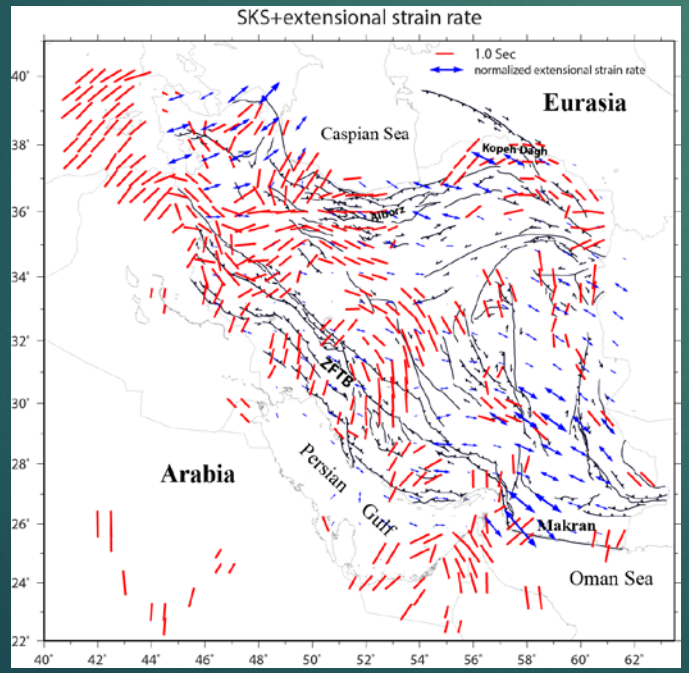


Figure 4: Anisotropy fast directions (red bars) overlapped on the maximum extensional geodetic strain rate directions (two-sided blue vectors)

Correlation between maximum shear strain at the surface and fast anisotropy directions in eastern Iran (simple shear along strike-slip faults)

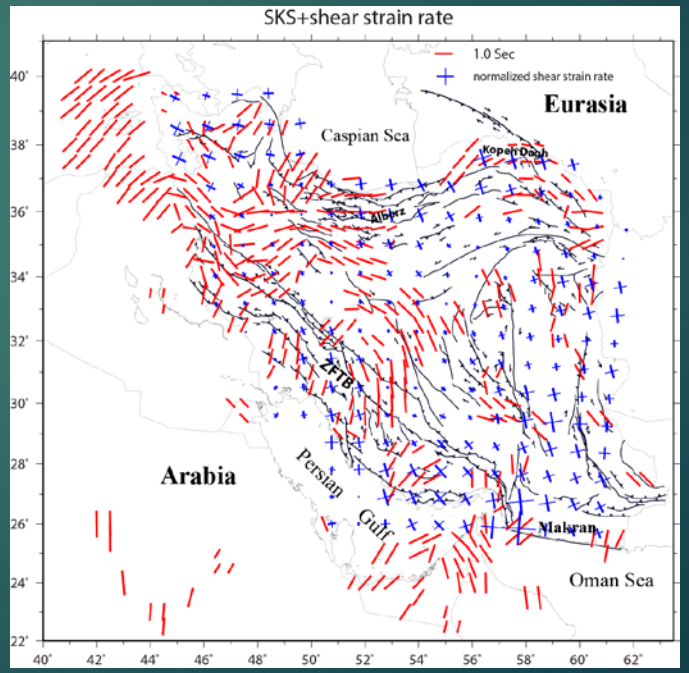
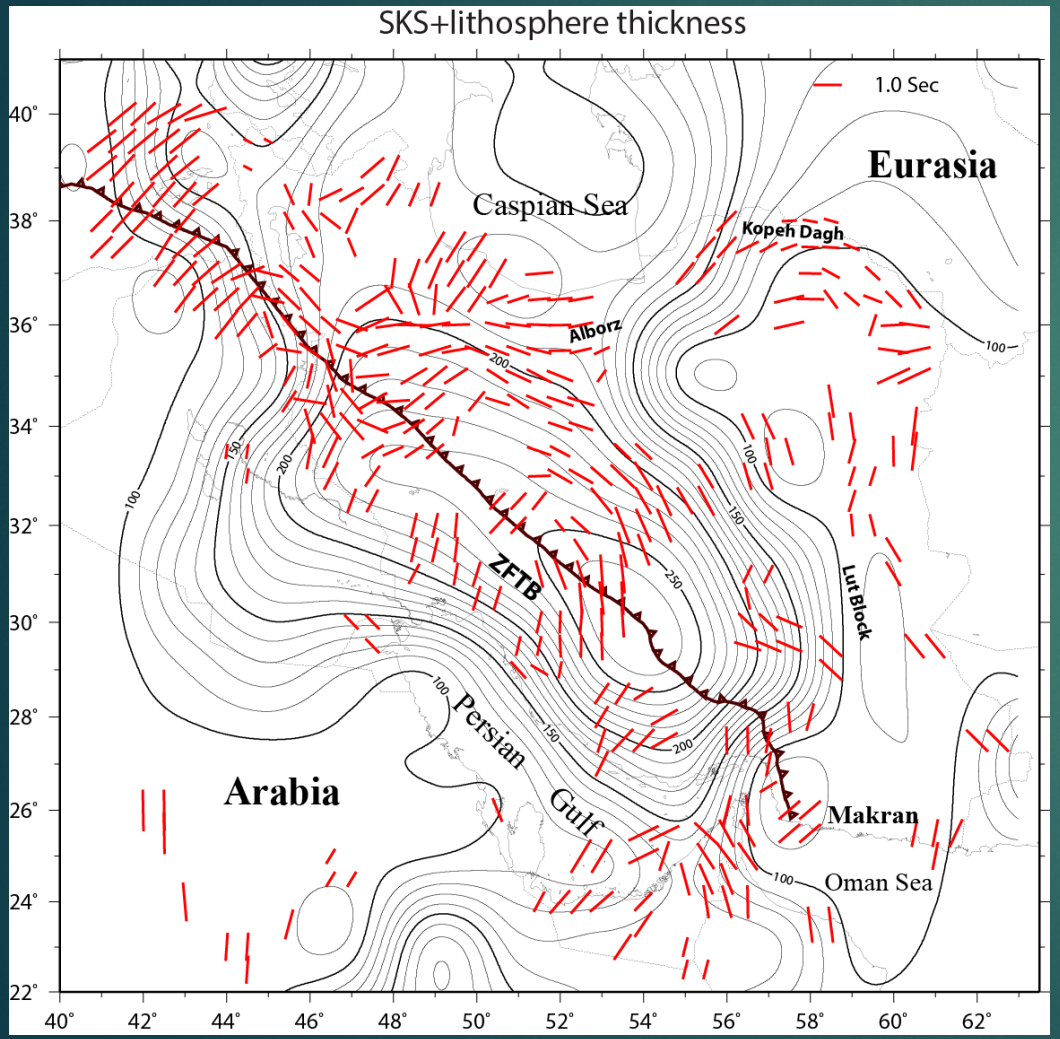


Figure 5: Anisotropy fast directions (red bars) overlapped on the maximum extensional geodetic strain rate directions (orthogonal blue bars)

Lithospheric deformation and/or asthenospheric flow?



- Fast anisotropy direction are oriented in the trend of lithospheric thickness contour lines
- Lateral variation in the lithosphere thickness affects the flow in the mantle
- Circular mantle flow around the thick Zagros lithosphere

Figure 6: Anisotropy fast directions (red bars) overlapped on the lithospheric thickness contour map

Summary

We suggest that the complex pattern of mantle anisotropy beneath the Zagros and Iranian Plateau occurs from a complex contribution of the lithosphere deformation and asthenospheric flow:

- APM parallel, plate-driven viscous flow everywhere beneath the Arabian Platform, Zagros and eastern Turkey
- Circular mantle flow around the Zagros keel
- Narrow region in the NW Zagros, toroidal flow, slab window?
- Lithospheric pure shear beneath the eastern Alborz and Kopeh-Dagh
- Simple shear of the lithosphere along the large scale shear zones in eastern Iran