Shallow Asthenospheric Volumes in the Circum-Mediterranean and their Relation to Intraplate Volcanism and Topography

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- Relation between thin lithosphere (shallow asthenosphere) and crustal tectonics, topography, and anorogenic volcanism?
- Spatial distribution of shallow asthenosphere in the Mediterranean?
- Consistent imaging of the upper mantle in the Mediterranean down to about 300 km depth by Rayleigh wave tomography
- Unprecedentedly dense sampling with surface-wave measurements, using all available data (1990-2015)
- Stochastic inversion of fundamental Rayleigh mode dispersion curves
- Lateral resolution between about 75 km and 200 km
- Vertical resolution between about 20 km and 50 km
The Mediterranean
Measurement of Fundamental Rayleigh Mode Dispersion Curves

ca. 3800 regional and teleseismic events
1990 - 2015

ca. 4500 stations
ca. 3.5 M waveforms
heterogeneous station distribution and
data quality

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Stochastic Inversion of Fundamental Rayleigh Mode Dispersion Curves

Examples: Eastern Alps

Anatolia

Low Vs between about 70 km and 200 km depth: shallow asthenosphere

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3D Shear-Wave Velocity Model (70 km – 300 km depth)

depth: 100 km
\( V_{SV} \): 4.34 km/s

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Shallow Asthenospheric Volumes

AAA: Aegean Anatolian Asthenosphere
CEA: Central European Asthenosphere
MeA: Middle East Asthenosphere
PnA: Pannonian Asthenosphere
RRA: Rhone-Rhein Asthenosphere
SeA: Serbian Asthenosphere
WMA: Western Mediterranean Asthenosphere

EEC: East-European Craton
EMOML: Eastern Med. Oceanic Mantle Lithosphere
WECML: Western Europ. Cont. Mantle Lithosphere

depth: 100 km
$V_{SV}$: 4.34 km/s
Shallow Asthenospheric Volumes and Anorogenic Volcanism

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Shallow asthenosphere beneath Massif Central, Ligurian Sea, and Sardinia

MC: Massif Central

SAR: Sardinia

RRA: Rhône-Rhine Asthenosphere

WECML: Western European Continental Mantle Lithosphere

WMA: Western Mediterranean Asthenosphere
Shallow asthenosphere beneath northern Aegean and Anatolia

AegS : Aegean Sea
AAA: Anatolian-Aegean Asthenosphere
He: Hellenides Slab
Conclusions

- Almost closed circular belt of shallow asthenosphere around Mediterranean comprising of: Western Mediterranean, Rhone-Rhein, Central European, Pannonian, Serbian, Aegean-Anatolian, and Middle East Asthenosphere
- Shallow asthenosphere and elevated topography:
  - Continental Plateaus (Iberia, Anatolia, central European mid-mountain ranges)
  - Continental Shoulders (e.g. Atlas, Bohemian Massive, Middle East)
- Shallow asthenosphere and subsidence in extensional regimes:
  - Graben systems (Rhone-Rhein Graben)
  - Back-arc basins (Western Mediterranean, Pannonian Basin, Aegean)
- Spatial correlation: shallow asthenosphere and anorogenic volcanic fields
- Growing of continental lithosphere by cooling (e.g. North German Basin, Paris Basin)