Comparison of the crust and upper mantle structure of the Alboran and Algerian domains (Western Mediterranean): Tectonic significance

Ajay Kumar
Manel Fernàndez
Jaume Vergés
Ivone Jiménez-Munt
Montserrat Torné

Group of Dynamics of the Lithosphere, Institute of Earth Science Jaume Almera (ICTJA-CSIC), Barcelona, Spain
- HP/LT Metamorphic rocks
- Back-arc basins
- Volcanism
  - **Orogenic**
    - Valencia Trough
      - Early Miocene-Middle Miocene
      - Calc-alkaline (Martí et al. 1992)
    - Alboran Basin
      - Si-K-rich (Upper Miocene-Lower Pliocene)
      - (Duggen et al. 2004)
  - **Anorogenic**
    - Valencia Trough
      - Middle Miocene-recent
      - Alkaline
    - Alboran Basin
      - Si-poor, Na-rich Upper-Miocene-Pleistocene

Trans-tensive and **highly extended continental segments** transition to oceanic lithosphere to the east.

Stampflti & Borel 2002; Schettino & Turco 2011; Nirrengarten et al. 2018; Vergés et al. 2019
Alboran Slab

Travel time inversion

Villaseñor, Spakman and Engdahl, 2003

Algerian Slab

Full waveform inversion

Fichtner and Villaseñor, 2015
Can the opposite polarity subduction model explain the present day crust and upper mantle structure in the Alboran and Algerian basin?
**Physical state**
- Temperature
- Pressure
- Composition (Major Oxides)

**Thermodynamics**

**Mineral physics**

**Density**
- Elevation
- Gravity anomalies
- Geoid Height

**Seismic velocities**
- Synthetic seismic tomography
- Surface wave dispersions
- Receiver functions

**LitMod2D_2.0**
- Improved from LitMod2D_1.0 (Afonso et al., 2008)
- Depleted mid oceanic ridge basalt mantle (DMM, *Workman and Hart, 2015*) in the sublithospheric mantle
- Anomalies in sublithospheric mantle
  - Thermal
  - Compositional
  - Seismic velocities
- Anelastic attenuation parameters from recent laboratory measurements
  *Kumar et al. 2020*
Crustal scale model

High velocity anomaly at shallow depths (~4 km)

Low velocity anomaly at mid-crustal depths

Lack of data!
Mass deficit beneath Betic ridge. Slab?
Oceanic slab still not enough.
Slab with same composition as Iberian lithosphere.

\[ dT = -320 \, ^{\circ}C \]
Mass deficit beneath Kabylies.
Slab with oceanic lithosphere composition fits better.
Summary

- Thick lithospheres on opposite sides.
- The Alboran slab is less fertile than the Algerian slab.
- Relatively fertile mantle beneath Alboran and Algerian Basin.

Schematic illustration, not to scale!
Lithospheric Mantle: Chemical composition

PUM - Primitive Upper Mantle
(McDonough & Sun 1995)

DMM - Depleted Mid-oceanic-basalt Mantle
(Workman & Hart 2005)

Tecton_Tc_1 - Average Garnet Tecton
(Griffin et al, 2009)

Proton_Pr_6 - Average Proton Lherzolite
(Griffin et al, 2009)

CVP - Calatrava Volcanic Province
(Villaseca et al. 2010)