Coupled mantle dripping and lateral dragging controlling the lithosphere structure of the NW-Moroccan and the Atlas Mountains

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http://www.lacan.upc.edu/
Jiménez-Munt et al. JGR, 2011
Decoupled crust-mantle accommodation of Africa-Eurasia convergence in the NW Moroccan margin

Jiménez-Munt et al., JGR, 2011
Margin lithosphere significantly thicker than previous models
Decoupling between crust and mantle

Crustal shortening domain
(~950 km wide)

Shortening
>20 km
10-20 km
13-30 km

Tagus Plain
Cotting Bank
Horseshoe Plain
Seine Plain
coastline
Moroccan Mesale
High Atlas
Sahara Platform
W African Craton

Moho
LAB
pre-shortening LAB

lithospheric mantle thickening (~400 km wide)
lithospheric mantle thinning

Lithospheric shortening domain
Jimenez-Munt proposes a drip&drag mechanism

Asymmetric process (different from std RT) concentrates deformation on one side
Drag contributes to both, thickening of the margin and thinning at Atlas

Is this process physically feasible? (under reasonable geophysical assumptions)
Numerical Experiment

- Domain 1: Oceanic
  - 2 mm yr⁻¹

- Domain 2: Passive Margin
  - T=273K

- Domain 3: Atlas
  - T=1880K

- Domain 4: Craton

Depth (km):
- η (Pa s)
  - 10²⁰ to 10²⁵
- ρ (kg m⁻³)
  - 2800 to 3400
- Κ (W m⁻¹ K⁻¹)
  - 2.5 to 4.5
Results - Evolution of model with strong lithosphere
Results - Evolution of model with weak lithosphere
Results - Crust-Mantle decoupling
Results - Topography

uplift during last 8-15 Ma
(Babault, 2008)
Results - Speculative evolution: subduction initiation?
Conclusions

• A mechanism of asymmetric instability producing thickening beneath the margin and lateral mantle drag and thinning beneath the continental domain is **dynamically feasible** under plausible conditions.

• The asymmetry of the process depends on the existence of lateral strength variations in the lithosphere (e.g. a passive margin).

• This mechanism could account for present-day lithospheric structure across the NW-Moroccan margin and Atlas mountains.
Thank you!

Questions or comments?

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Results -

Symmetric evolution if no strength lithospheric contrast between ocean and continent
Results - Volcanism

Miocene to Pliocene alkanine volcanism in Atlas
(Missenard and Cadoux, 2012)

Decompression melts due to rapid ascent of mantle material produce a relatively large degree of melt (7 to 10%) in the late stage (last 15 My)
Results - Speculative evolution: delamination