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The structure and dynamics of the ultra-slow Western Mediterranean arcs (Gibraltar and Calabria): Unresolved questions and ongoing work

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The western Mediterranean region has been shaped by subduction and roll-back of a Tethys oceanic domain between Africa and Eurasia over the past 30 million years. Since about 5 Ma only two small fragments of this once larger oceanic domain survived, in the Ionian Sea and in the Gulf of Cadiz, each in turn related to two highly arcuate subduction arcs: the Gibraltar arc (S. Iberia) to the west and the Calabrian arc (S. Italy) to the east. Many consider this geodynamic episode to be nearly finished or possibly even terminated. In the past decade geophysical work has improved our understanding, for instance with tomography yielding images of the complex 3-D geometry of the descending slabs, seismological work revealing the associated flow patterns in the upper mantle, and wide-angle seismic work demonstrating the presence of oceanic crust in the Gulf of Cadiz. Bathymetric swath-mapping has revealed the fine morphology related to surface processes (faulting, folding, and gradual or even catastrophic downslope transport).
But numerous questions remain, such as: How does fragmentation of a once wide oceanic domain occur (slab detachment and lateral tears)? What is the magmatic response during this evolution (presence and geochemical evolution of the arc and other magmatism)? Are all the slabs today completely detached and are the associated narrow arcs now dead and truly inactive? Or does ultra-slow subduction persist with an associated long-term seismic hazard? Can we clearly identify kinematic blocks related to these arcs and what are the relative motions as measured by GPS? How is continuing overall oblique convergence between the major plates being accommodated? (e.g. - Is a large-scale plate tectonic re-organization currently taking place)? Finally, what is the precise extent of the oceanic crustal domains and what is the structure of the adjacent margins? And knowing this, can we reconstruct the original rifting history and better understand modern day subduction segmentation and slab fragmentation? A series of recent seismic studies (based on newly acquired data as well as reprocessing of existing data) provides partial answers to some of these questions, while identifying a need for new, targeted marine geophysical surveys. Two projects on the deformation front and possible lithospheric tear-fault (STEP fault) of the Calabrian subduction will be described, the CIRCEE-HR project (scheduled for Sept. 2013) and future wide-angle seismic work (DIONYSUS project). Additional 2-D and 3-D numerical modelling work can potentially provide new insights regarding the deep processes of slab detachment and lateral segmentation and can benefit from the geometric constraints provided by the crustal structure work.