Mantle degassing in a collisional zone: Subduction types A & B in the Central Mediterranean

Antonio Caracausi1, Attilio Sulli2, Maurizio Gasparo Morticelli2, Marco Pantina2, Paolo Censi2, Vincenzo Stagno3,6, Andrea Billi4, Martina Coppola3, and Claudia Romano5

1Istituto Nazionale di Geofisica e Vulcanologia (INGV), sezione di Palermo, Palermo, Italy (antonio.caracausi@ingv.it)
2Dipartimento Scienza della Terra e del Mare, Università di Palermo, Italy (attilio.sulli@unipa.it)
3Dipartimento Scienza della Terra, Sapienza Università di Roma, Italy (vincenzo.stagno@uniroma1.it)
4Consiglio delle Nazionali Ricerche, IGAG, Rome, Italy (andrea.billi@cnr.it)
5Dipartimento di Scienze, Università di Roma Tre, Roma, Italy (claudia.romano@uniroma3.it)
6Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

The central Mediterranean is a very complex area constituted by a puzzle of different lithosphere segments, whose geological evolution is controlled by the interaction between the European and African plates. Within this geological domain, the northern Sicily continental margin and adjacent coastal belt represent a link between the Sicilian chain and the Tyrrenian extensional (back-arc) area in the north-south direction, whereas in the east-west direction a transition from a subduction type B (Ionian-Tyrrenian) to a continental collisional system, subduction type A, (Sicilian-Maghrebian Chain) is recognized.

The structure of the lithosphere in this area is matter of a strong debate. Most uncertainties on the geologic evolution of the boundary between the European and African plate at depth rise from the lack, up to now, of constraints and clear evidence of geometry of the lithosphere down to the crust-mantle interface.

In order to investigate the regional crust-mantle tectonics, here we discuss recent deep seismic reflection data, gravimetric modelling, the regional fluid geochemistry coupled to the seismicity that clearly indicate presence, along this sector of the Central Mediterranean, of a hot mantle-wedging at about 28 km of depth. This wedge lies just below a thick-skinned deformed belt cut by a dense system of faults down to the Mohorovicic discontinuity.

We also discuss new geochemical data in mineralization (fluorite) of hydrothermal deposits along the main regional faults above the mantle wedge. The mineralization is strongly enriched in saline fluid inclusions that allowed high precision analyses of the trapped volatiles (H2O, CO2 and noble gases).

Notwithstanding the region is far from any evidence of volcanism (Etna volcano and Aeolian Islands are in about 80km), the new geochemical data highlight the presence of mantle-derived volatiles that degas through the crust (e.g., He isotopes, up to 1.4Ra, Ra is the He isotopic ratio in
atmosphere). An excess of heat sourced from the mantle characterizes the region. This is a rare case of occurrence of mantle volatiles together with heat in a collisional system.

The active regional seismicity indicates that the mantle fluids move from the mantle wedge to the surface, hence across the ductile crust that could be thought as a barrier to the advective transfer of fluids because of its low permeability on long time scales. Here we reconstruct the deep faults by the deep seismic reflection data that works as a network of pathways that actively sustains the advective transfer of the mantle fluids through the entire continental crust.

Finally, the new geochemical data strongly supports that 1) the mantle wedge and possible associated magmatic intrusions as the source of the mantle volatiles outgassing in the region. A comparison of the noble gases isotopic signature of fluids coming from the mantle wedge and those emitted from the Mt Etna volcano furnish new constrain on the mantle composition below the central Mediterranean getting new constrains to the processes that controlled the geodynamic evolution of the central Mediterranean (i.e., delamination processes).