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Active geodynamic in the central Mediterranean: Transfer of mantle fluids across the north-eastern Sicily

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Mantle degassing occurs principally through active volcanic systems and young oceanic lithosphere. Tectonically active regions on the continental crust may additionally contribute a (poorly quantified) fraction of the deep CO_2 budget. It is a powerful tracer to recognize the release of mantle volatiles, which are enriched in 3He relative to the crust.
We studied volatiles in thermal manifestations along the seismically active Nebrodi-Peloritani chains (NE Sicily), to investigate the origin of thermalism and fluids. The geological evolution of the area has been controlled by the interaction between the European and African plates and links the African Maghreb with the European Apennines. The collected samples exhibit 3He excess, supporting active outgassing of mantle-derived volatiles. The computed mantle-derived He fluxes are up to 3 orders of magnitude higher than in stable continental areas. These high fluxes support advective fluids transport through regional tectonic discontinuities.
The area, despite being a chain, is located between two of most active volcanic systems, Mt. Etna to south and the Aeolian arc to north. Geophysical studies and experimental models [Piromallo et al., 2003] suggest the existence of toroidal flows in the mantle that, bypassing the subduction plate, produce mantle upraise in the area [Faccenna et al., 2011], eventually leading to magma accumulation at the mantle-crust interface, or in the crust. We propose gas ascent occurs via deep regional tectonic discontinuities (the Eolie-Tindari-Letojanni fault system, named ATLFS), interpreted by either an offshoot of a regional lithospheric structure in the Ionian Sea [Polonia et al., 2016], or a slab tear or STEP type structure at the margin of subduction ionian plate [Doglioni et al., 2001]. Our study supports a) the possible presence of magmatic intrusions below this sector of the Maghrebian-Apenninic chain; b) the active role of the regional discontinuities in transferring mantle fluids towards the surface and c) the possible age of the magmatic intrusions.
Finally our results furnish new contributions to the crust-mantle tectonic in a region that is dominated by the interaction of two plates. Hence this study produces new contributions for a better knowledge of the geodynamic evolution of Mediterranean.

Reference

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