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New insight on the lithospheric structure of the Betic Cordillera: Contribution of the gas geochemistry

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The Betic Cordillera (Spain) is a tectonically active zone corresponding to the European western part of the Alpine peri Mediterranean orogenic belt. Although this is well admitted that this orogenic belt results from the Iberia-Africa plate convergence from the Mesozoic onward, its lithospheric structure and geodynamic processes explaining the formation of this arcuate structure surrounding the Alboran Sea are still debated. According to recent geophysical studies, the present position of the slab require a westward slab detachment or tearing beneath the Betic Cordillera, resulting in a sharp change in lithospheric thickness with possible asthenospheric influx. Therefore, the region would be a transition zone between a thick lithosphere in the Iberian domain and a thin lithosphere in the Alboran domain. In this study we use fluid geochemistry associated with the geological and geophysical interpretations of the Betic Cordillera to set constraints on its lithospheric structure and the involved tectonics processes.

Here we present the chemical and isotopic composition of helium, neon and carbon dioxide of bubbling and dissolved gases in well and springs waters of the Betic Cordillera in order to evaluate the origin of gases and to understand the relationship between fluid geochemistry, tectonics and geodynamics in the region. Gas samples located close to the major tectonic discontinuities structuring the Betic Cordillera (Cadiz-Alicante fault, IEBZ, and detachments of the metamorphic complexes) show high proportions of CO_2 ($> 50\%$) suggesting gas-water interactions processes with volatile-rich fluids. In addition, the helium and neon isotopic compositions of bubbling and dissolved gases range from air composition to mainly crustal composition (R/Ra and ^{4}He/^{20}Ne ratios ranging from 0.06 to 1.03 and from 0.4 to 32.87 respectively). Therefore, we show that the crustal radiogenic He signal is predominant whereas the mantle-derived He contribution reaches 1% maximum for the investigated fluids. This suggests that gases mainly originate from crust and reach the surface via faults rooted into the upper crust. We propose that slow diffusion of mantle-derived He within a ductile lower crust might explain the low contribution measured at the surface. The preliminary results of diffusion calculations are in good agreement with this hypothesis given the thickness and the diffusion coefficient of the ductile lower crust that mantle-derived He would have to cross below the Betic Cordillera. Hence, our gas geochemistry data combined with the geophysical interpretations brings constraints on the lithospheric structure of the Betic Cordillera.