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Post-orogenic evolution of the Eastern Betics: the tectono-sedimentary and fluid record of the Tabernas Basin (Spain)

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In the Eastern Betics, the late orogenic evolution is still strongly debated. Since Miocene times, crustal thinning associated with the retreating Tethyan slab resulted in the exhumation of high-pressure metamorphic basement along the intra-montane sedimentary basins and hydrothermal fluid circulations. Recent works have focused on the links between the structure of Miocene basins and their internal sedimentary architectures, but only a few studies questioned the relationships between basin infill history, tectonic structure, exhumation of metamorphic complexes, and regional uplift with the different generation of mineralized fluids. Here, we focus on the Tabernas basin, in the Almeria Province, a well exposed extensional basin in which we have reconstructed the spatio-temporal evolution of the fluid paths.

Field investigations show a North-South asymmetric extensional system interrupted by Tabernas basin depression filled by Miocene clastic series and sparse continental carbonates. Detailed observations compiled with published data show that most of the exhumation, occurred from 30 to 18 Ma, as a result of EW extension. Shear zones that developed during this main exhumation period are contemporaneous while Si- and Fe-rich fluids fossilized in the foliation planes. The first generation of Si- and Fe-mineralized fluids predated or was coeval with the ductile deformation. Then, the final exhumation from 14 to 8 Ma, was associated with the formation and the main brittle structures in the extensional basins. Detailed geological mapping show a clear link between Ca- and Fe-rich fluids pathways and N50 and N170-trending normal faults that cut across the metamorphic domes and temporally interfere with magmatic events (from 12 to 7 Ma). A subsequent compressional event in the end of the Tortonian favors the reactivation of previous extensional faults, reopening fractures and faults. The following deposition of travertines on the current reliefs testifies of the latest Ca- and CO_2-rich fluids flows in the system. The water chemistry indicates deep basin fluids flows (CO_2/H2S-rich fluids) related to the nature of the basement, including magmatic rocks. These travertines precipitate along N50 and N170 faults and through alluvial deposits implying both tectonic- and clastic sedimentation-controlled. They are Pleistocene in age (U-Th dating) and coincide with the regional uplift since Pliocene times.

Based on an analysis of the fluid factory, combined with a study of the spatial and temporal distribution of sedimentary facies, and a deep structural interpretation of onshore constraints, we bring new insights on the Miocene evolution of the Eastern Betics.