Superposition of nappe stacking and extensional exhumation in the Sierra de los Filabres (Southeast Spain)

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The Sierra de los Filabres mountain range in the Betics system of SE Spain is one of the best natural laboratory to investigate processes associated with nappe stacking and subsequent exhumation of metamorphic rocks during the orogenic evolution. Existing research separates the Iberia-derived high-pressure, amphibolite facies Nevado-Fillabrides complex in a lower tectonic plate position from the lower grade ALCAPECA microcontinent-derived Alpujárride complex in an upper tectonic plate position. Their nappe-stack contact is also defined as an extensional detachment that controls the exhumation of the higher grade Nevado-Fillabrides complex. We have tested this model with a detailed (micro-)structural and lithological analysis complemented by \(^{40}\)Ar/\(^{39}\)Ar white mica dating of key shear zones. We aim to define key shear zones that separate different tectonic units, to determine the kinematics and timing of main deformation phases, and to understand the interplay between burial and exhumation structures. The results show that shearing related to the subduction burial up to the amphibolite facies is ~ top-NW in present-day coordinates. Three amphibolite facies nappe units are distinguished, which may correspond to proximal and more distal parts of the former hyper-extended Iberian margin. The bottom and top nappes consist of continental material, while the middle nappe is largely made of mafic and ultramafic rocks. Top-NW shearing was coeval with the isoclinal and tight asymmetric folding of the formations. These structures were overprinted by upright folds and greenschist facies shear zones that still developed under compression. These contractional structures are cross-cut by ~ top-W shear zones associated with exhumation that show evidences of gradually decreasing P-T conditions during extension from ductile shearing to normal faulting. We show that the same protolith can be followed in amphibolite grade below and in low greenschists grade above the main extensional detachment. This demonstrates that the extensional detachment did not follow and reactivate exactly the former nappe contact between the Nevado-Fillabrides and Alpujárride complexes. Our single grain fusion \(^{40}\)Ar/\(^{39}\)Ar ages on white micas show a range of 10 to 20 Ma in case of nappe contacts or extensional shear zones, while yield a significantly older, 25-40 Ma age cluster in case of a sample far away from the main shear zones in the core of the Nevado-Fillabrides dome. This age cluster could either represent excess Ar in the sample, or resetting due to a distinct tectono-metamorphic event that occurred prior to the Early Miocene subduction of the Nevada-Fillabrides complex. The latter case would require the reconsideration of recent tectonic reconstructions of the region.