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Permian rifting and detachment faults and their role in Alpine collisional tectonics

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The Permian was a time of strong crustal extension in the area of the later-formed Alpine orogen. This involved extensional detachment faulting and the formation of metamorphic core complexes. We describe (1) an area in the Southern Alps (Valsassina, Orobic chain) where a metamorphic core complex and detachment fault have been preserved and only moderately overprinted by Alpine collisional shortening, and (2) an area in the Austroalpine (Schneeberg) where Alpine deformation and metamorphism are intense but a Permian low-angle normal fault is reconstructed from the present-day tectonometamorphic setting. In the Southern Alps case, the Grassi Detachment Fault represents a low-angle detachment capping a metamorphic core complex in the footwall which was affected by upward-increasing, top-to-the-southeast mylonitization. Two granitoid intrusions occur in the core complex, c. 289 Ma and c. 287 Ma, the older of which was syn-tectonic with respect to the extensional mylonites (Pohl, Froitzheim, et al., 2018, Tectonics). Consequently, detachment-related mylonitic shearing took place during the Early Permian and ended at ~288 Ma, but kinematically coherent brittle faulting continued. Considering 30° anticlockwise rotation of the Southern Alps since Early Permian, the extension direction of the Grassi Detachment Fault was originally ~N-S and the sense of transport top-South. In this area, there is no evidence of Permian strike-slip faulting but only of extension. In the Schneeberg area of the Austroalpine, a unit of Early Paleozoic metasediments with only Eoalpine (Cretaceous) garnet, the Schneeberg Complex, overlies units with two-phased (Variscan plus Eoalpine) garnet both to the North (Ötztal Complex) and to the South (Texel Complex). The basal contact of the Schneeberg Complex was active as a north-directed thrust during the Eoalpine orogeny. It reactivated a pre-existing, post-Variscan but pre-Mesozoic, i.e. Permian low-angle normal fault. This normal fault had emplaced the Schneeberg Complex with only low Variscan metamorphism (no Variscan garnet) on an amphibolite-facies metamorphic Variscan basement. The original normal fault dipped south or southeast, like the Grassi detachment in the Southern Alps. As the most deeply subducted units of the Eoalpine orogen (e.g. Koralpe, Saualpe, Pohorje) are also the ones showing the strongest Permian rift-related magmatism, we hypothesize that the Eoalpine subduction was localized in a deep Permian rift system within continental crust.