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Late Variscan lithospheric extension in the northern Schwarzwald basement (SW-Germany): its possible role in locating the Cenozoic Rhine Graben Rift

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Late stage extension of thickened crust and the development of a relatively planar Moho-discontinuity appear to have been the most significant process in the development of the modern lithosphere underlying the Variscan massifs of Central Europe. As these massifs are commonly bounded or cut by late Mesozoic to Cenozoic structures such as the Upper Rhine Graben the question arises as to what kind of inherited lithospheric heterogeneities might have controlled the development of the structures bounding the massifs. Recent observations made in the northern Schwarzwald basement - confirming data reported previously from areas in the graben shoulders of the Odenwald and southern Schwarzwald - suggest the possibility that a major late Variscan lithospheric zone of extension and related zones of extensional transfer localized later uplift, inversion and rift structures.

The crystalline basement of the northern Schwarzwald consists mainly of high-grade migmatitic paragneiss-orthogneiss complexes (Central Schwarzwald Gneiss Complex, CSGC) which were intruded by S-type granites around 325±5 Ma. Although they are considered broadly as post-tectonic these granites and a northerly trending gneissic roof pendant (Omerskopf Gneiss) display mylonitic to brittle fabrics which document a tens of kilometers long and several hundred meters thick W-dipping shear zone (Glashütte Shear Zone). Indeed, detailed mapping suggests that some formerly mapped pre-Variscan orthogneisses are probably mylonitic Variscan S-type granites. Rapid emplacement and exhumation of granites in the footwall of a NNE-trending lithospheric shearzone – as indicated by granitic pebbles in nearby late Carboniferous (315-300 Ma) basins – therefore most likely occurred during late orogenic crustal thinning. Crustal thinning probably coincided with the development of planar structures in the lower crust and with the creation of a new planar Moho. Since footwall and hanging wall of the shear zone were intruded by northerly trending granitic to rhyolitic dykes E-W-extension apparently continued to be active during and after cooling of granitic plutons.

On a regional scale we therefore infer that the Upper Rhine Graben rift stucture developed along a major inherited lithospheric (crust + uppermost mantle) weakness zone (Glashütte shear zone) along which a W-dipping extensional shear zone separates Variscan higher level crust from deeper crustal components. Its continuity on strike has not yet been established to our satisfaction possibly due to local sinistral transfer zones

and polyphase tectonic reactivations and late stage intrusions which may have camouflaged the shear zone in places. Such a W-dipping shear zone might help to understand 1) the rapid exhumation of deep crustal rocks of the CSGC and granites in the Schwarzwald, 2) the relatively shallow crustal levels and abundant sedimentary rocks which dominate exposures in the hanging wall area, represented by the pre-Permian basement exposures in the Vosges and Pfälzerwald on the west side of the URG, 3) the distinct rift asymmetry with W-dipping border faults dominating the northern URG, 4) higher seismicity towards the eastern shoulder of the rift structure. This hypothesis could be tested by targeting seismic studies onto deeper crustal and uppermost mantle structures.