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Geogenic Gases and Red Wood Ant Clusters as Indicators for Neotectonic Activity at the Peninsula Bodanrück (South West Germany)

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The peninsula Bodanrück (South West Germany) is situated at the crosscut zone of two major fault systems, the "Permokarbontrog" and the Cenozoic "Freiburg-Bonndorf-Hegau-Bodensee-Graben". The Trog, striking approximately NE-SW, is sheared by WSW–ENE to W-E trending faults. The Graben is controlled by the recent compressional stress field in NNW-SSE direction leading to a WSW-ENE extensional regime, in which NW-SE, NNE-SSW and NS trending faults cut through the entire crust combined with uplift and subsidence (Ziegler & Dèzes 2007, Pavoni 1984, Nagra 1992). The northern boundary of the Graben is marked by the Mindelsee fault, which extends in the longitudinal direction of the Bodanrück and splits into several smaller units, which are not yet fully understood (Schreiner 1992). To the South, the Graben is bordered by the Randen fault zone several hundred meters wide. Whether the Graben further extends across the entire Bodanrück is still under discussion (HSK 2005).
Red wood ants (Formica rufa-group, RWA) are bioindicators for identifying hidden neotectonic strike-slip faults (Berberich 2010, Schreiber & Berberich 2011). At the Bodanrück, we investigated if a combination of soil gas analyses and RWA mound distribution can be used to complement this neotectonic fault regime southeast of the Mindelsee.
Geogenic gas analyses for carbon dioxide (CO_2), helium (He) and radon (Rn) showed significantly increased anomalies, providing evidence of spotty degassing anomalies and neotectonic stress comparable to those measured in the Neogene Basins of Italy or the Westeifel Volcanic Field (Ciotoli et al. 2006, Berberich 2010). Anomalous CO_2 values (up to 11 Vol. %) agree well with high Rn anomalies suggesting a fit with supposed local fault systems (Kemski et al. 1996, Ferrari et al. 2003). This correlation confirms the presence of deep reaching gas-bearing channels in the study area.
The agglomeration of RWA in the study area is embedded between the Mindelsee and the Randen fault zones. Although small-scale distribution of RWA mounds did not correspond directly to geogenic gas concentrations (Berberich et al. 2012), their large-scale arrangement in three major rhomboidal clusters (1,276, 790 and 120 mounds) corresponding to three tectonic blocks directly maps the main stress field and the conjugated shear system in hierarchically succession. Two nest free corridors trending about [U+F0B1][U+F020]20° NNE-SSW separate these blocks and correlate well with the hypothesized NNE-SSW trending faults east of Stein am Rhein derived from focal plane analyses and might be linked to the northern edge of the "Permokarbontrog" (Graf 2009, Müller et al. 2002). These RWA-free corridors are interpreted as non-gaspermeable normal faults. The RWA nest distribution within the clusters show mostly NNW-SSE, WSW-ENE and NNE-SSW trending zones, which we associate as strike-slip faults, matching well those known from the Graben regime (Swisstopo 2008). The blocks are subjected to uplift, but they also undergo possible rotations relative to one another, which can be correlated with voids caused by dextral crustal block rotation. Considering all aspects, we interpret our findings as a possible double transpressional pop-up structure embedded between two dextral strike-slip faults prolonging the Mindelsee and Randen strike-slip faults.

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