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Statistical Correlation between Red Wood Ant Sites and Neotectonic Strike-Slip Faults

G. Berberich (1), D. Klimetzek (2), C. Wöhler (3), and A. Grumpe (3)

(1) University Duisburg-Essen, Faculty of Biology, Department of Geology, Universitätsstr. 5, 45141 Essen, Germany, (2) Albert-Ludwigs-University of Freiburg, Faculty of Forest and Environmental Sciences, Department of Forest Biometry, Tennenbacher Str. 4, 79085 Freiburg, Germany, (3) TU Dortmund, Faulty of Electrical Engineering and Information Technology, Image Analysis Group, Otto-Hahn-Straße 4, 44227 Dortmund, Germany

Recent research in the West Eifel (West Germany) has demonstrated the correlation of soil gas anomalies and spatial distribution of red wood ant (RWA) mounds along strike-slip faults. RWA can be used as biological indicators for the identification of neotectonic fault systems (Berberich 2010, Schreiber & Berberich 2011). For myrmecologists, the causes and stringency of such a linkage are paramount, since linear patterns have been mostly associated with edge effects of forest stands and/or roads (Klimetzek 1970, Klimetzek & Kaiser 1995, Wellenstein 1990). Therefore, geostatistical techniques were applied in the West Eifel and the Bodanrück (South West Germany) to distribution data of approx. 3,000 resp. 2,300 mounds of RWA (Formica spp., Hymenoptera: Formicidae) in correlation with known neotectonic fault systems

Both study areas are located in areas with a complex tectonic history. Commenced during the Neogene and persisted during the Quaternary, the uplift of both, the Rhenoherzynikum and the Black Forest, affects the dynamics of the study areas and reactivates pre-existing Palaeozoic crustal discontinuities. The West Eifel (Rhenoherzynikum) was tectonically sheared in Mesozoic and Cenozoic times. The current NW-SE-trending main stress direction opens pathways for geogenic gases. At the same time, Variscan faults as part of a conjugated shear system, are reactivated. At the Bodanrück, the compressional stress field (NNW-SSE) leads to a WSW-ENE extensional regime, in which faults cut through the entire crust (Ziegler & Dèzes 2007, Nagra 1992). The prominent large-scale neotectonic structure is the NW-SE to WNW-ESE trending "Freiburg-Bonndorf-Hegau-Bodensee-Graben" that consists of several sub-trenches (Müller et al. 2002). Field surveys indicate a possible existence of a NNE-SSW trending strike-slip fault extending east of Stein am Rhein (Büchi & Müller 2003) possibly reactivated in the Quaternary (Birkhäuser et al. 2001). Available focal mechanism solutions show a lack of possible fault planes striking between 40 and 90 degrees from north (Deichmann 1990). In addition, a NNW-SSE and NS trending fault system exist.

We tested the hypothesis that the spatial distribution of RWA mounds would map the neotectonic stress field directly (Berberich et al. 2012). A statistical method for the automatic extraction of linear patterns from point clouds (Hough transform) was applied to the spatial distribution of RWA mounds. The maxima of the resulting histograms denote the preferential alignment directions.

In both cases, it could be clearly shown that the spatial distribution of RWA mounds directly map the main stress field and the conjugated shear system in hierarchically succession. In the West Eifel, RWA depict mainly the opening direction of the Quaternary volcanic field (NW-SE), the WSW-ENE extensional regime and the reactivated Variscan fault systems (NNE-SSW, NE-SW). At the Bodanrück, the hypothesized existence of the NNE-SSW strike-slip fault systems (Büchi & Müller 2003) and additionally NE-SW, NNW-SSE and NS directions could be demonstrated.

In conclusion, the statistical analyses show that spatial distribution of RWA maps neotectonic, gaspermeable strike-slip faults. This is especially useful in those cases, where information about the neotectonic regime is incomplete or the resolution by technical means is insufficient.

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