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GIS-based LiDAR-DEM5 lineament analysis in crystalline basement rocks of the central and northern Black Forest, SW-Germany

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Favorably oriented brittle fault zones in a regional stress field are major targets for geothermal exploration and production. Particularly, knowledge of spatial distribution and orientation of brittle fault zones in crystalline basement rocks contribute to our understanding of structural relationships, fault kinematics, and to natural and induced seismicity in EGS reservoirs. In order to quantify distribution and orientation of fault zones in crystalline basement rocks a Geoinformation System (GIS) based lineament analysis has been carried in the central and northern Black Forest as a first follow-up study of Meixner et al. (2018) who provided a lineament analysis for the southern Black Forest. Data base for lineament analysis are LiDAR-DEM5-data that were transformed into raster datasets, hillshaded and analysed in GIS. Inclined faults intersecting with a topography with different orientation than the strike direction of the fault will appear as curvilinear features at a map surface and hence will not be mapped as lineaments Subvertical faults instead will be mapped as lineaments independent either of topography or orientation of the fault. Hence inclined faults will commonly be underrepresented by a regional lineament analysis. For statistical consistency and comparability, e.g. for evaluation of the lineament orientation distribution, each lineament was cut in 500 m long segments. The remaining end pieces of each lineament length below 500 m are statistically regarded as equivalent to the regular 500 m segments.
The orientation distribution of mapped lineaments shows maxima for NE-SW-(040-065°), NNW-SSE-(155-170°), and N-S-(170-010°) trends and minima for E-W-(080-095°) and ESE-WNW-(100-125°) trends. The predominant NE-SW- and NNW-SSE-trending lineaments can be referred to late Carboniferous-early Permian volcano-sedimentary basins (e.g. Rupf & Nitsch, 2008). This is in marked contrast to the southern Black Forest where WNW-ESE-trending lineaments prevail (Meixner et al., 2018). As NE-trending lineaments display little reactivation potential in the regional stress field natural seismicity is distinctly less than in the southern Black Forest where NW-trending faults with high reactivation potentials prevail (Meixner et al. 2018).

References

Meixner J, Grimmer JC, Becker A, Schill E, Kohl T (2018) Comparison of different digital elevation models and satellite imagery for lineament analysis: Implications for identification and spatial arrangement of fault zones in crystalline basement rocks of the southern Black Forest (Germany). Journal of Structural Geology, v. 108, p. 256-268, doi: 10.1016/j.jsg.2017.11.006

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