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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)

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Abstract

GIS-based remote sensing techniques and lineament mapping provide additional information on the spatial arrangement of faults and fractures in large areas with variable outcrop conditions. Due to inherent censoring and truncation bias mapping of lineaments is still a challenging task. In this study we show how statistical evaluations help to improve the reliability of lineament mappings by comparing two digital elevation models (ASTER, LIDAR) and satellite imagery data sets in the seismically active southern Black Forest. A statistical assessment of the orientation, average length, and the total length of mapped lineaments reveals an impact of the different resolutions of the data sets that allow to define maximum (censoring bias) and minimum (truncation bias) observable lineament length for each data set. The increase of the spatial resolution of the digital elevation model from 30 m x 30 m to 5 m x 5 m results in a decrease of total lineament length by about 40% whereby the average lineament lengths decrease by about 60%. Lineament length distributions of both data sets follow a power law distribution as documented elsewhere for fault and fracture systems. Predominant NE-, N-, NNW-, and NW-directions of the lineaments are observed in all data sets and correlate with well-known, mappable large-scale structures in the southern Black Forest. Therefore, mapped lineaments can be correlated with faults and hence display geological significance. Lineament density in the granite-dominated areas is apparently higher than in the gneiss-dominated areas. Application of a slip- and dilation tendency analysis on the fault pattern reveals largest reactivation potentials for WNW-ESE and N-S striking faults as strike-slip faults whereas normal faulting may occur along NW-striking faults within the ambient stress field. Remote sensing techniques in combination with highly resolved digital elevation models and a slip- and dilation tendency analysis thus can be used to quickly get first order results of the spatial arrangement of critically stressed faults in crystalline basement rocks.

1 Introduction

Identification of brittle faults in basement rocks is still a challenging task because fault traces are commonly more difficult to recognize and to track along strike in crystalline basement than in