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On the reliability of manually produced bedrock lineament maps

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Manual extraction of topographic features from digital elevation models (DEMs) is a commonly used technique to produce lineament maps of fractured basement areas. There are, however, several sources of bias which can influence the results.
In this study we investigated the influence of the factors (a) scale, (b) illumination azimuth and (c) operator on remote sensing results by using a LiDAR (Light Detection and Ranging) DEM of a fractured bedrock terrain located in SW Norway. Six operators with different backgrounds in Earth sciences and remote sensing techniques mapped the same LiDAR DEM at three different scales and illuminated from three different directions. This resulted in a total of 54 lineament maps which were compared on the basis of number, length and orientation of the drawn lineaments. The maps show considerable output variability depending on the three investigated factors. In detail: (1) at larger scales, the number of lineaments drawn increases, the line lengths generally decrease, and the orientation variability increases; (2) Linear features oriented perpendicular to the source of illumination are preferentially enhanced; (3) The reproducibility among the different operators is generally poor. Each operator has a personal mapping style and his/her own perception of what is a lineament.
Consequently, we question the reliability of manually produced bedrock lineament maps drawn by one person only and suggest the following approach: In every lineament mapping study it is important to define clear mapping goals and design the project accordingly. Care should be taken to find the appropriate mapping scale and to establish the ideal illumination azimuths so that important trends are not underrepresented. In a remote sensing project with several persons included, an agreement should be reached on a given common view on the data, which can be achieved by the mapping of a small test area. The operators should be aware of the human perception bias. Finally, any remote sensing study has to be regarded as a preliminary exercise and, ideally, should be followed by ground truthing of the obtained results.