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# Topographic attributes as a guide for automated detection or highlighting of geological features

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Photogrammetry or LIDAR technology combined with photography allow geoscientists to obtain 3D high-resolution numerical representations of outcrops, generally termed as *Digital Outcrop Models* (DOM). For over a decade, these 3D numerical outcrops serve as support for precise and accurate interpretations of geological features such as fracture traces or plans, strata, facies mapping, etc. These interpretations have the benefit to be directly geo-referenced and embedded into the 3D space. They are then easily integrated into GIS or geomodeler softwares for modelling in 3D the subsurface geological structures.

However, numerical outcrops generally represent huge data sets that are heavy to manipulate and hence to interpret. This may be particularly tedious as soon as several scales of geological features must be investigated or as geological features are very dense and imbricated. Automated tools for interpreting geological features from DOMs would be then a significant help to process these kinds of data. Such technologies are commonly used for interpreting seismic or medical data. However, it may be noticed that even if many efforts have been devoted to easily and accurately acquire 3D topographic point clouds and photos and to visualize accurate 3D textured DOMs, few attentions have been paid to the development of algorithms for automated detection of the geological structures from DOMs.

The automatic detection of objects on numerical data generally assumes that signals or attributes computed from this data allows the recognition of the targeted object boundaries. The first step consists then in defining attributes that highlight the objects or their boundaries. For DOM interpretations, some authors proposed to use differential operators computed on the surface such as normal or curvatures. These methods generally extract polylines corresponding to fracture traces or bed limits. Other approaches rely on the PCA technology to segregate different topographic plans. This approach assume that structural or sedimentary features coincide with topographic surface parts.

In this work, several topographic attributes are proposed to highlight geological features on outcrops. Among them, differential operators are used but also combined and processed to display particular topographic shapes. Moreover, two kinds of attributes are used: unsupervised and supervised attributes. The supervised attributes integrate an *a priori* knowledge about the objects to extract (e.g.: a preferential orientation of fracture surfaces, etc.). This strategy may be compared to the one used for seismic interpretation. Indeed, many seismic attributes have been proposed to highlight geological structures hardly observable due to data noise. The same issue exist with topographic data: plants, erosions, etc. generate noise that make interpretation sometimes hard.

The proposed approach has been applied on real case studies to show how it could help the interpretation of geological features. The obtained “topographic attributes” are shown and discussed.