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# Combination of photogrammetric and geoelectric methods to assess 3d structures associated to natural hazards

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The extraction of subsurface materials is a key element for the economy of a nation. However, natural degradation of underground quarries is a major issue from an economic and public safety point of view. Consequently, the quarries stakeholders require relevant tools to define hazards associated to these structures. Safety assessment methods of underground quarries are recent and mainly based on rock physical properties. This kind of method leads to a certain homogeneity assumption of pillar internal properties that can cause an underestimation of the risk.
Electrical Resistivity Imaging (ERI) is a widely used method that possesses two advantages to overcome this limitation. The first is to provide a qualitative understanding for the detection and monitoring of anomalies in the pillar body (e.g. faults). The second is to provide a quantitative description of the electrical resistivity distribution inside the pillar. This quantitative description can be interpreted with constitutive laws to help decision support (water content decreases the mechanical resistance of a chalk).
However, conventional 2D and 3D Imaging techniques are usually applied to flat surface surveys or to surfaces with moderate topography. A 3D inversion of more complex media (case of the pillar) requires a full consideration of the geometry that was never taken into account before.
The Photogrammetric technique presents a cost effective solution to obtain an accurate description of the external geometry of a complex media. However, this method has never been fully coupled with a geophysical method to enhance/improve the inversion process.
Consequently we developed a complete procedure showing that photogrammetric and ERI tools can be efficiently combined to assess a complex 3D structure. This procedure includes in a first part a photogrammetric survey, a processing stage with an open source software and a post-processing stage finalizing a 3D surface model. The second part necessitates the production of a complete 3D mesh of the previous surface model to operate some forward modelization of the geo-electrical problem. To solve the inverse problem and obtain a 3D resistivity distribution we use a double grid method associated with a regularized Gauss-Newton inversion scheme.
We applied this procedure to a synthetic case to demonstrate the impact of the geometry on the inversion result. This study shows that geometrical information in between electrodes are necessary to reconstruct finely the “true model”. Finally, we apply the methodology to a real underground quarry pillar, implying one photogrammetric survey and three ERI surveys. The results show that the procedure can greatly improve the reconstruction and avoid some artifacts due to strong geometry variations.