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Fracture characterization of flysch formation by terrestrial digital photogrammetry: an example in the Antola Formation (upper Staffora Valley, Italy)

Claudia Meisina, Niccolò Menegoni, and Cesare Perotti
University of Pavia, Department of Earth and Environment Sciences, Pavia, Italy (claudia.meisina@unipv.it)

Geomechanical characterization of flysch formations plays an important role for its implication in slope stability and fluids circulation, especially in Apenninic areas.
The Antola Formation of Upper Cretaceous age crops out extensively in the Northern Apennines and provides an important case of study. It consists of turbiditic graded units of calcareous sandstones, sandstones, marlstones, and shales and is interpreted as a deep-sea basin plain deposit, with lateral facies variations which range from proximal, thick-bedded turbidities to distal turbidites that show predominantly thickening upward cycles and have a high percentage of shale. It is in general characterized by folds developed in absence of metamorphism and a usually high degree of fracturation. The presence of well developed fracture networks enhances circulation of fluid and therefore alteration of the less competent layers causing problems of slope stability.
Fracture characterization of Antola Formation based on field survey is very time consuming and often limited by the insufficient availability and inaccessibility of outcrops. For this reason, terrestrial remote sensing and in particular terrestrial digital photogrammetry has been applied to investigate the geomechanical features of the formation in the upper Staffora Valley (Northern Italy).
Digital photogrammetry allows to generate by Structure from Motion (SfM) technique a 3D point cloud that represents the Digital Outcrop Model (DOM). New technologies allow to associate appropriate texture to the point cloud from the images, in order to preserve important visual information. The analysis of several textured 3D DOMs allows to digitally acquire a large amount of data on discontinuities parameters such as orientation, spacing, aperture, persistence and filling, in order to better characterize the rock mass. Some tests performed by field survey data acquisition to validate the digitally collected data, gave positive results, showing differences in the measures in the order of 5%.
In the examined DOMs three or four set of fractures have been identified. The principal set is formed by the bedding that always intersects the other sets; moreover the other sets are in general perpendicular to the bedding. The fracture system seems strictly connected to the tectonic deformations (folds and faults) locally affecting the Antola Formation.
The advantages of the terrestrial digital photogrammetry techniques applied to fracture characterization are not only the possibility to acquire a larger amount of data of inaccessible outcrops or in a lower time, but also the acquisition of georeferenced data of the single fractures. This type of acquisition of data can be very useful in the fracture network modeling.