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Fracture characterization of the Lastoni di Formin carbonate platform (Italian Dolomites) using a 3D high-resolution digital outcrop model generated from UAV imagery

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The features and the distribution of the fractures strongly influence the permeability of carbonate reservoirs, controlling the circulation of fluids and storage capacity. Studying the interaction of fractures, tectonic evolution, distribution of facies and geometries of an outcropping carbonate platform can be useful to understand the conditions of analogous subsurface bodies.
We present the workflow and the preliminary results of the 3D structural analysis that were performed on the beautifully exposed “Lastoni di Formin” outcrop: a wide and up to 400 m high portion of the Averau-Nuvolau carbonate platform, in the Italian Southern Alps (Dolomites), which has been affected by two main tectonic phases: the Jurassic rifting and the Alpine compression. The ’3D’ geometry and the huge dimensions (more than 2 km2) of the studied outcrop allow to analyze the variation of fractures features and distribution around the platform. Due to the difficult access to some portion of the outcrop (e.g. vertical rock cliffs), the study was realized by the use of Unmanned Aerial Vehicle Digital Photogrammetry (UAVDP) technique. The 3D Digital Outcrop Model (DOM) developed by Structure from Motion (SfM) algorithm was interpreted and sampled in a 3D environment using the open-source software Cloud Compare.
This procedure has substantial advantages in respect to field-based manual sampling as the possibility to reach inaccessible outcrops; the possibility of working on the digital dataset every time (i.e. in winter, when the outcrop is completely covered by the snow); the opportunity of realizing faster coverage of large areas; the acquisition of more representative geological measurements ("smoothing" of the local variations).
Specifically, we focused on the extraction of quantitative 3D data from the DOM, building a wide dataset of fractures and bedding measurements, including orientation, fault displacements and beds thicknesses. These data have been integrated with LiDAR data, aerial imaging and field observations, in order to describe the relations between the variability of the fracture network and the facies distribution of the platform. Three principal sets of steeply dipping fractures, oriented about N25°, N125° and N160°, have been identified; some of them also shows evidence of small displacements, probably connected to Alpine tectonic reactivation.