



Structural analysis by UAV and terrestrial digital photogrammetry of flysch formation (Monte Antola Formation - Ponte Organasco, Italy)

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The deformation structures (folds and fractures) affecting Monte Antola flysch formation in the area of Ponte Organasco (Northern Apennines - Italy) have been analyzed by Unmanned Aerial Vehicle (UAV) Digital Photogrammetry (UAVDP) and Terrestrial Digital Photogrammetry (TDP). These techniques allow the realization of Digital Outcrop Models (DOMs) that have been interpreted and sampled in a stereoscopic environment collecting a large number of structural measures (strata and fractures and successively fold axes and axial planes). The structural analysis reveals the presence of a series of NE-vergent folds that have a typical Apenninic trend and are affected by three main sets of fractures. This fracture network is always sub-orthogonal to the bedding, maintains constant angular relationships and seems linked to the folding deformation. The study shows that UAVDP and TDP techniques can overcome the main limitations of the field structural analysis such as the scarce presence and the inaccessibility (total or partial) of rock outcrops, or the local variations of measured features (e.g. waved/undulated surface) and some biases (e.g. orientation and truncation bias) due to the technique of sampling (e.g. scanline, window, etc.). In particular, UAVDP, in comparison to TDP, allows to acquire images of rock outcrops from user-inaccessible positions and may overcome occlusion and vertical orientation biases of the higher part of outcrops, due to the lack of an optimal positioning of the camera with respect to the rock exposure.