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Mapping the vertical: Oblique LIDAR acquisition for mapping Dolomites cliff (NE Italy)

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The challenging work of 3D surveying and accurately modeling of vertical cliffs in the “Tre Cime di Lavaredo” (Dolomites mountains, NE Italy)is described. The Tre Cime di Lavaredo are often considered the "true" icon of the Dolomites, because they fully represent, with their shapes and colors, the concept itself of the UNESCO’s site, and are a typical example of landforms linked to morpho-selection, more specifically of morpho-tectostatics shape determined by the trends of important displacement and fracture lines and related belts of cataclastic rocks, which facilitate differential weathering and erosional processes. The vertical dimension of these and similar mountain complexes are usually unmapped and poorly resolved in a cartographic “nadir-dominated” world. The goal of the project called “Peaks-3D” is the highly detailed 3D surveying of the “Tre Cime di Lavaredo”, especially their vertical cliffs, nearly 600 meter high, for digital documentation and conservation, geological and geomorphological analysis, tourism and communication purposes, 3D mapping of the ascent roots, etc. The digital recording of the current situation and the monitoring of ongoing processes are fundamental prerequisites for analyses and establishment of sustainable measures of protection.

The 3D recording is based on a fusion of oblique airborne and terrestrial laser scanning, in order to survey all the relief complex, focusing especially on the vertical cliffs. The aerial acquisitions are performed with the patented Helica system composed of an Optech system coupled with a GPS/INS unit, a Rollei digital camera and a NEC infrared digital camera. The oblique mounting of the laser scanner, although requires a more delicate flight planning, allows the detailed surveying of complex sites where a traditional nadir acquisition would not be sufficient. To overcome some recording gaps of the airborne LiDAR surveying, primarily due to occlusions and hidden rock features, two terrestrial field campaigns were performed. The aerial and terrestrial range data needed to be co-registered and merged into a unique and seamless 3D point cloud, considering the multi-resolution data and the 3D geometry (not 2.5D). Then, in order to produce photo-realistic 3D results, digital images were mapped onto the 3D geometric data. The availability of accurate and detailed 3D model over such complex cliffs offers the opportunity to systematically study relationships between relief shapes (e.g. rock faces) and the network of planar discontinuity (e.g. faults, fracture, joint and bedding) that will be extracted from the unstructured 3D point clouds and mesh, by testing both commercial and in-house software.

Range data provides also information about intensity of the scanned scene that is, in principle, proportional to the surface’s reflectance and depends on the physical and chemical properties of the surface. Experiments on reflectance series obtained from TLS data show intensity variations along a stratigraphic section and give an estimate of the rock content variations during the geological time and highlight cyclicities that can represent the clue of sedimentary cycles.