NEW TOOLS FOR THE STUDY OF HIGH-RESOLUTION DIGITAL OUTCROPS ORIENTED TO THE 3D GEOLOGICAL MODELS.

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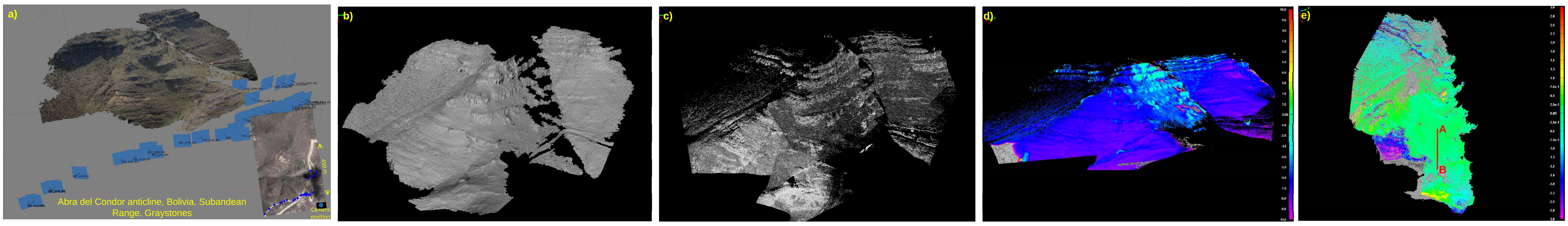
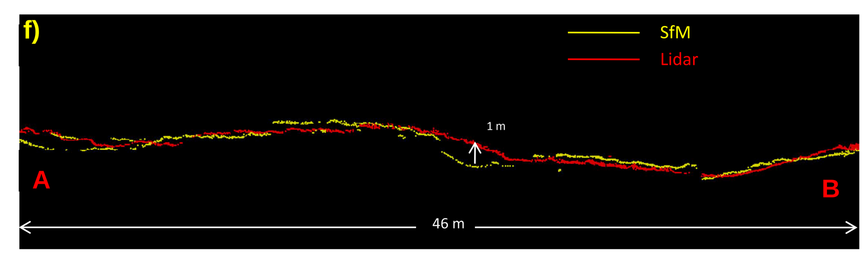
Example of Structure from Motion (SfM) Terrestrial Photogrammetry, differences with LIDAR data

SfM 3D TEXTURE MODEL | SfM 3D MODEL | LIDAR 3D MODEL | 1ST COMPARISON MODEL | 2ON COMPARISON MODEL



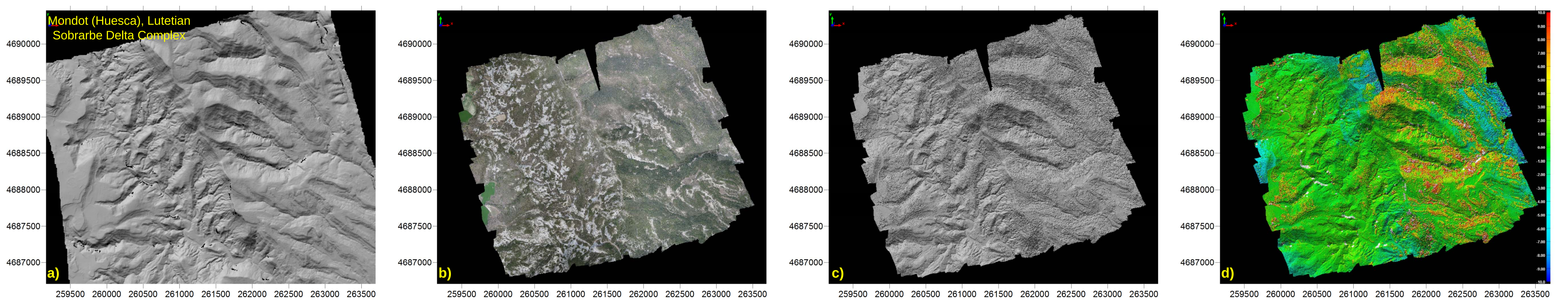
SfM is a technique evolution of the photogrammetry. Multitude of images can be collected by classical digital cameras equipped with a simple GPS to be processed with a high degree of automatism to create High-Resolution Models. Figures a) and b) are the processed results of 30 images over a cliff landscape. Figure c) shows the Terrestrial Lidar capture data (model Ilris-3D Optech Co.) from multiples stations with Differential GPS to georeference. The topographic differences between Lidar and SfM model (figure d)) reveals errors between 3 and 8 m due to the different GPS techniques employed. Figure e) corresponds to the differences between both models after align the SfM model respect to the Lidar model to correct GPS offset. The calculate errors are presented in figure e), for magnitude (SD is 1.5m) and geographic distribution. Figure f) present a topographic profile along both DTM. Lidar and SfM resolutions are comparables.

PROFILE LIDAR-SfM COMPARISON



Example of SfM in Aerial Photogrammetry from Unmanned Aerial Vehicles (UAV), Plane and Multicopter

AERIAL LIDAR 3D MODEL | PLANE SfM ORTHOIMAGE | PLANE SfM 3D MODEL | COMPARISON MODEL



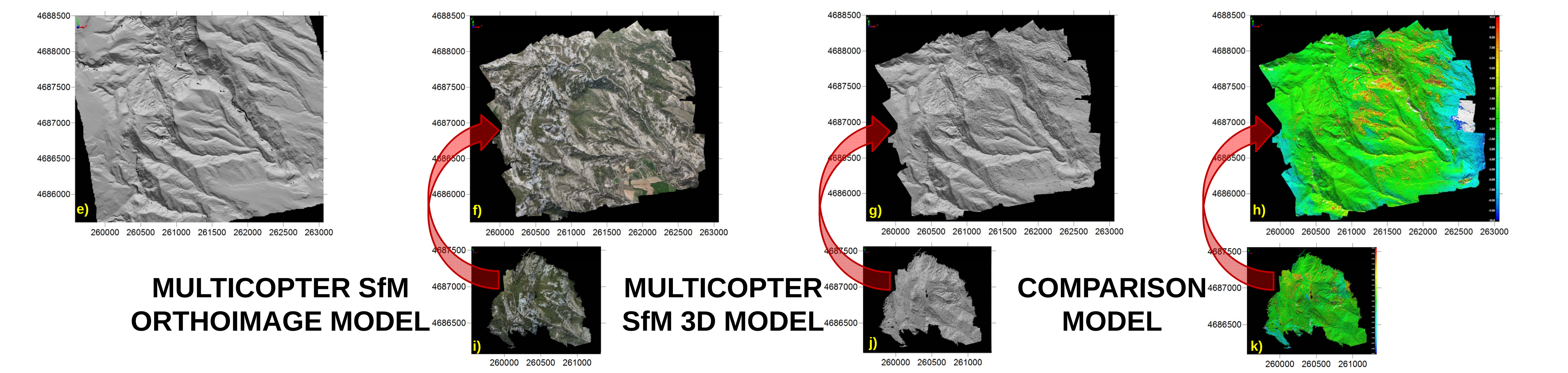
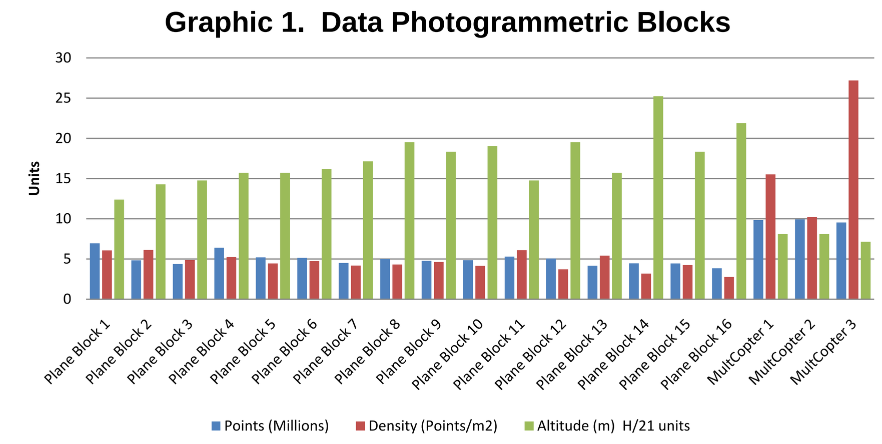


Table 1. Comparative results: Lidar (5m) and SfM DTMs

Photogrammetric Blocks	Hectares	Number of Images	Altitude (m)	Mean	Standard Deviation	Peak	Number of compared points
Plane Block 1	114.5	46	260	-0.06	2.08	4429	235496
Plane Block 2	78.7	30	300				
Plane Block 3	89.4	34	310				
Plane Block 4	122.1	43	330				
Plane Block 5	117.0	39	330	0.07	1.96	6683	288480
Plane Block 6	108.8	38	340				
Plane Block 7	108.0	40	360				
Plane Block 8	116.0	34	410				
Plane Block 9	103.1	33	385	0.09	1.84	6882	300289
Plane Block 10	116.3	38	400				
Plane Block 11	87.0	33	310				
Plane Block 12	136.0	40	410				
Plane Block 13	77.0	28	330	0.03	2.02	5501	297674
Plane Block 14	140.0	42	530				
Plane Block 15	104.6	31	385				
Plane Block 16	139.5	37	460				
Copter Block 1	63.5	129	170	0.03	1.64	475	27917
Copter Block 2	96.9	178	170	0.02	0.099	873	51609
Copter Block 3	35.1	182	150	0.01	0.62	406	21322

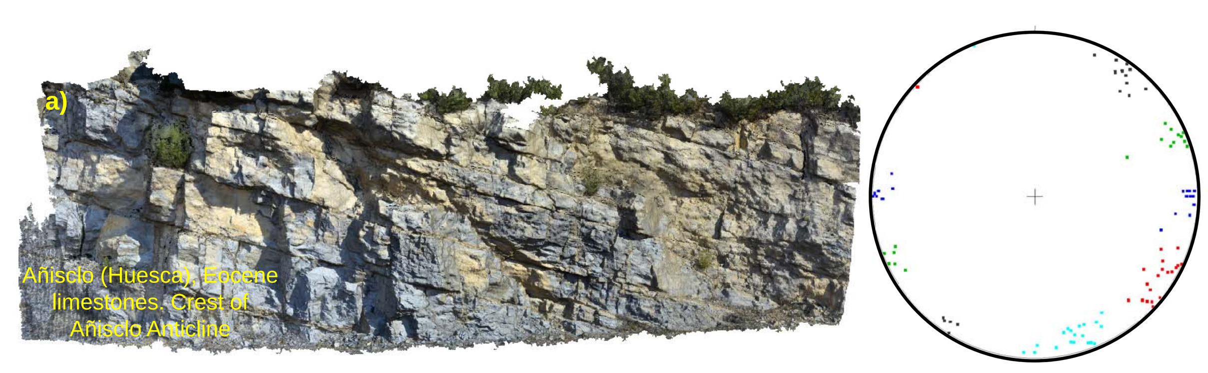
Graphic 1. Data Photogrammetric Blocks

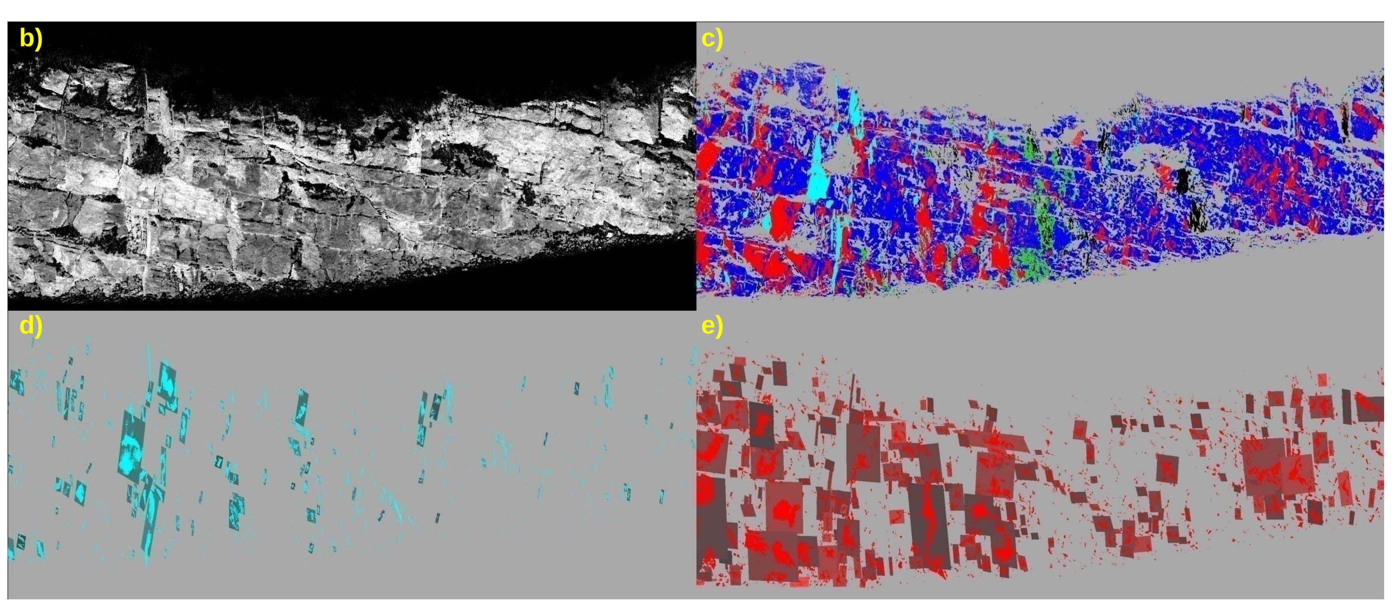


Six hundred aerial images were acquired from a UAV plane (ebee model of SenseFly thanks to the Dronebydrone company) equipped with a digital camera Canon Power Shot ELPH 110 HS (f: 4.3 mm) on an area of 10Km_2 in one hour. Sixteen photogrammetric blocks were constituted (Table and Graphic 1) and grouped in four block to compare with a Lidar DTM of 5m of grid (Source: Instituto Geográfico Nacional, IGN) in Figures a) and e). DTM and Orthoimage obtained by SfM processed are shown after grouped in pairs, figures b), c) and f), g). DTMs obtained were compared with the IGN DTM to evaluate the topography quality. Figures d) and h) illustrate the distribution and magnitude of the differences. Images acquired in three sessions of 15 minutes with a UAV multicopter were processed with SfM technique and compared with the IGN MDT. UAV multicopter was equipped with a digital camera Nikon 5100 (f: 18mm). Figures i), j) and k).

Tools for data extraction:

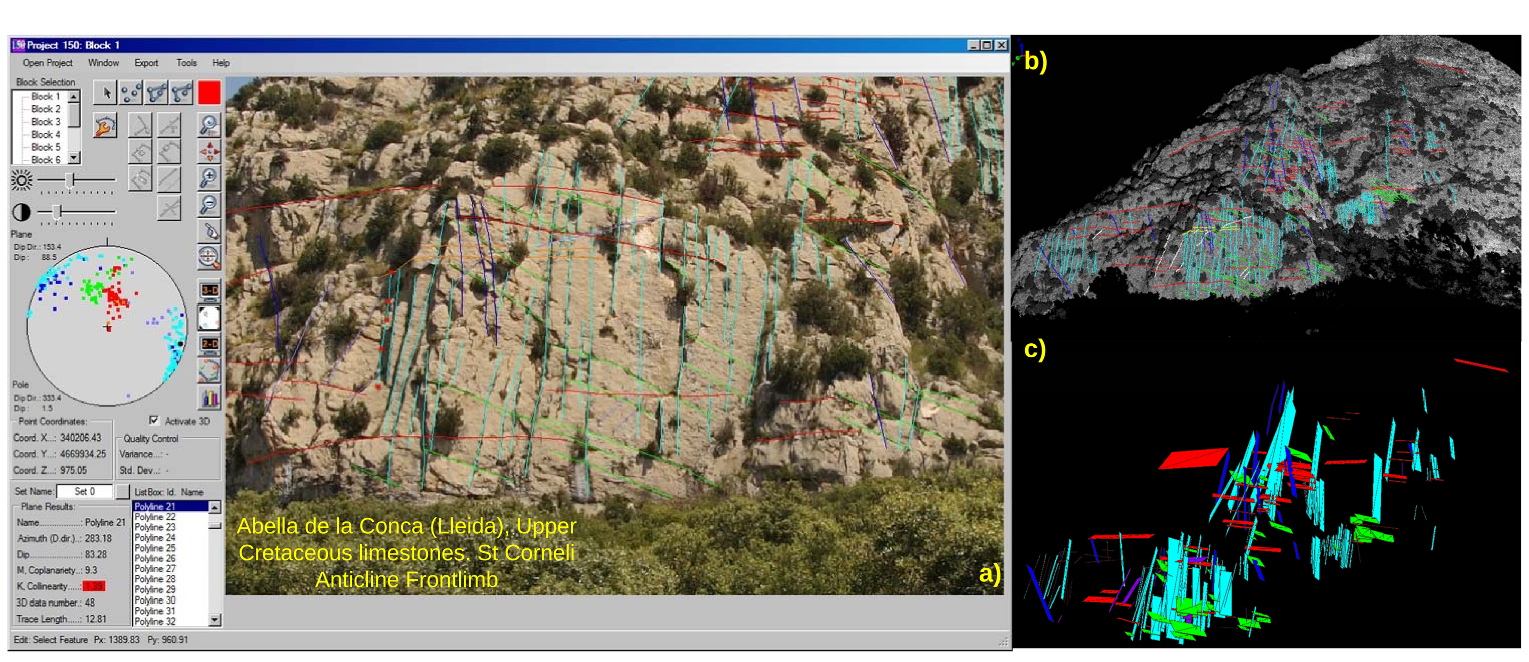
AUTOMATIC SURFACE EXTRACTION FROM DTM





Surface extraction is a tool developed by the Geomodels Research Institute to identify and extract surface points from a DTM. a) Orthoimage section of the outcrop (length: 27 m Height: 7 m) and the corresponding stereoplots of the five main fracture sets. b) Laser scanner section with TLS Intensity texture. c) Point Cloud image after identify and classify surfaces by fracture set orientation. Reconstructed fractures for fracture sets III d) and IV e)

TRACES DIGITIZATION TOOL



Traces digitization is a tool developed by the Geomodels Research Institute to extract linear geological structures from a High Resolution DTMs and images. Objects digitized over a image are projected onto the DTM to obtain 3D coordinates. Figure a) Digitizer interface. Polylines digitized in the 2D image are fitted to a plane and the orientation is plotted at the stereoplot. Different colors represent bedding and set fractures. b) Image composition from Lidar data and Intensity with the polylines projected. c) Digitization traces are reconstructed with planes to measure parameters like joint spacing, fracture height or fracture length for each set fracture.

Conclusions:

SfM technique is a valid technique to elaborate High Resolution DTMs. The technique is simple, fast and economic, therefore range, area surveyed and system positioning determine the quality. Images can be captured from aerial UAVs or mobile platforms.

Tools for geologic data extraction are not unusual in commercial software but can also be developed and improved by the geoscience community.

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drone by drone — By the UAV plane images acquisition. http: www.dronebydrone.com

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