

1. UNMANNED AERIAL VEHICLE-BASED PHOTOGRAMMETRY AND DIGITAL OUTCROP MODELLING

The Unmanned Aerial Vehicle (UAV)-based photogrammetric survey was conducted in June 2022 using two different kinds of quadcopters (Table 1): (i) DJI Phantom 4 RTK (P4RTK); (ii) DJI Mavic Air 2 (MA2).

Table 1. Specification of the UAV used to perform the Digital Photogrammetric survey

Type	DJI Phantom 4 RTK	DJI Mavic Air 2
Weight (payload included)	1391 grams	570 grams
Camera sensor size	1 inch	½ inch
Camera sensor resolution	20 megapixels	48 megapixels
GNSS type	Professional (Real Time Kinematic)	Consumer (standalone)
GNSS accuracy	< 5 cm	> 2 m

The UAV survey was conducted by both automatic and manual flight mode, and consisted in 12 photogrammetric missions for a total amount of about 30 flights and 11000 acquired photographs. Four automatic flight missions were planned using the P4RTK and the ‘Photogrammetry 2D’ planning mode of its in-built application. The flights were conducted at a mean altitude of about 90 meters, respect to the terrain, and imposing a nadiral camera setting and an image overlap/sidelap of 90%. This allows to acquire 6089 photographs with a mean resolution of about 2 cm/pixel.

Eighth UAV photogrammetric missions were conducted piloting manually both P4RTK and MA2. In general, the camera has been inclined from 0° (horizontal) to 30° and the mean camera-terrain distance has ranged from 47.8 m to 24.10, implying a mean photographs resolution that range from 3.9 mm to 1.17 cm. In Table 2 all the specification of the UAV photogrammetric mission are reported.

Table 2. Specification of the different UAV photogrammetric missions

Mission name	Mission type	UAV	Number of photographs	Mean camera-terrain distance (m)	Mean photographs resolution (cm/pixel)	Area surveyed (km2)
M1	automatic	P4RTK	2013	91.70	2.05	0.866
M2	automatic	P4RTK	1885	83.50	1.91	0.808
M3 A	automatic	P4RTK	1282	88.60	2.04	0.589
M3 B	automatic	P4RTK	909	83.20	1.88	0.441
TP A	manual	MA2	611	32.00	0.60	0.043
TP B	manual	MA2	521	27.50	0.59	0.039
NSP	manual	MA2	615	28.80	0.80	0.048
PSP	manual	MA2	437	30.10	0.78	0.025
CDV	manual	MA2	257	30.70	0.56	0.014
CVPS	manual	MA2	50	24.10	0.39	0.001
CV	manual	P4RTK	1501	41.00	1.17	0.087
CDP	manual	MA2	41	47.80	0.96	0.006

The acquired photographs were used to develop the Digital Outcrop Models (DOMs) following the work by Menegoni et al. (2022): (i) the photographs has been elaborated using their full-resolution with the Structure from Motion (SfM) and Multi-View Stereo (MVS)-based software Agisoft Metashape v. 1.6 (Agisoft LCC, retrievable at <https://www.agisoft.com/>); (ii) the DOMs developed using the P4RTK datasets have been georeferenced using the information registered by the on-board GNSS-IMU of the P4RTK; (iii) the DOMs developed using the MA2 datasets have been georeferenced using the P4RTK-related DOMs. This procedure allows to obtain a high accuracy dataset of DOMs.

DOMs were then analyzed following the procedure described by Inama et al (2020) and Panara et al. (2022) that mainly consist in visualize and analyze the DOMs by the use of a suite of tools of the open-source software CloudCompare (retrievable at <http://www.cloudcompare.org/>) and a Pluriview 28 UHD stereoscopic device.

REFERENCE LIST

- Inama R., Menegoni N. & Perotti C. (2020) - Syndepositional fractures and architecture of the Lastoni di Formin carbonate platform: Insights from virtual outcrop models and field studies. *Mar. Petrol. Geol.*, 121, 104606. <https://doi.org/10.1016/j.marpetgeo.2020.104606>
- Menegoni N., Inama R., Crozi M. & Perotti C. (2022) - Early deformation structures connected to the progradation of a carbonate platform: The case of the Nuvolau Cassian platform (Dolomites-Italy). *Mar. Petrol. Geol.*, 138, 105574.
- Panara Y., Menegoni N., Carboni F., & Inama, R. (2022) - 3D digital outcrop model-based analysis of fracture network along the seismogenic Mt. Vettore Fault System (Central Italy): the importance of inherited fractures. *J. Struct. Geol.*, 161, 104654. <https://doi.org/10.1016/j.jsg.2022.104654>

2. ORIGINAL FIELD PICTURES AND DOMS



Figure 6



Figure 8

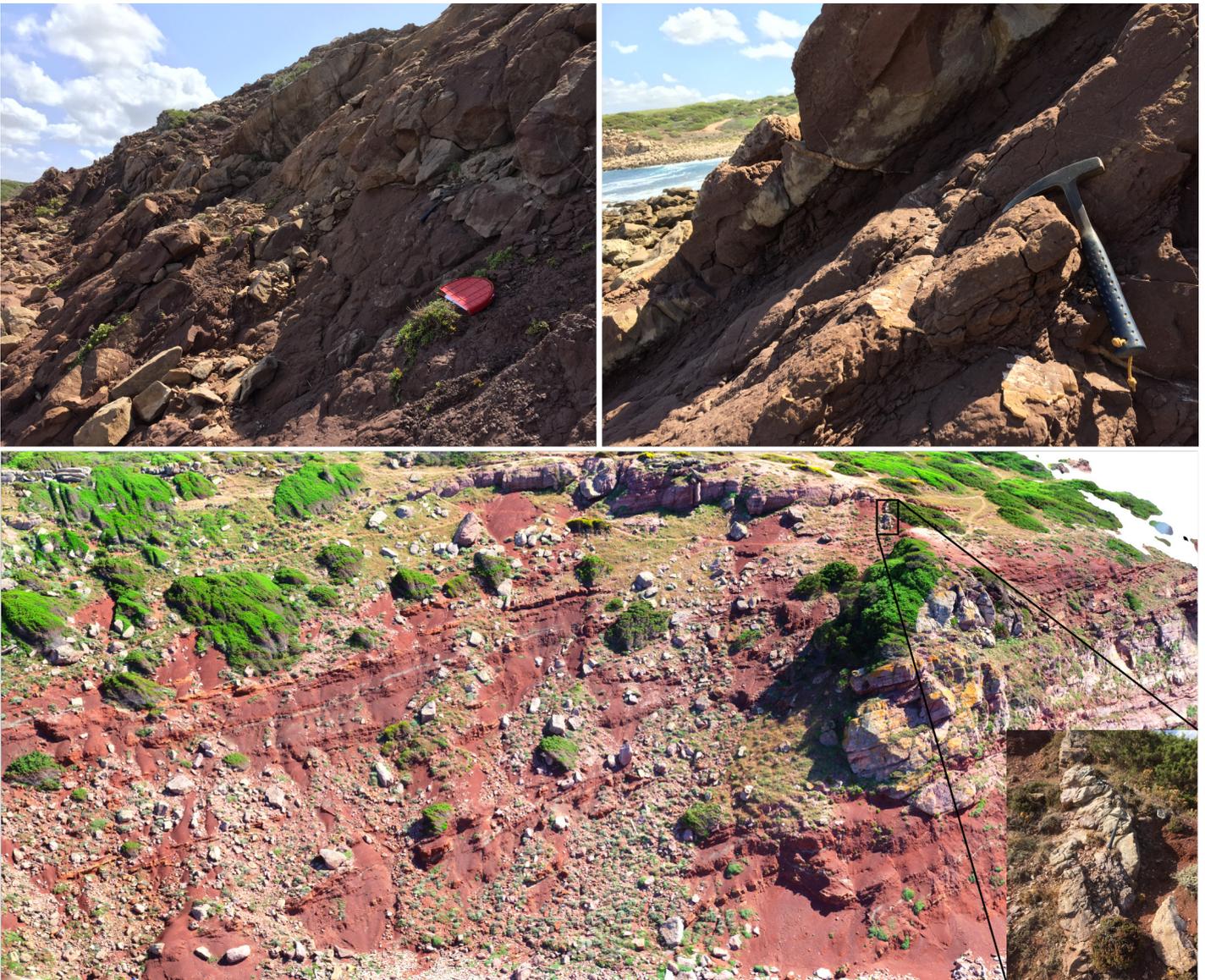


Figure 9

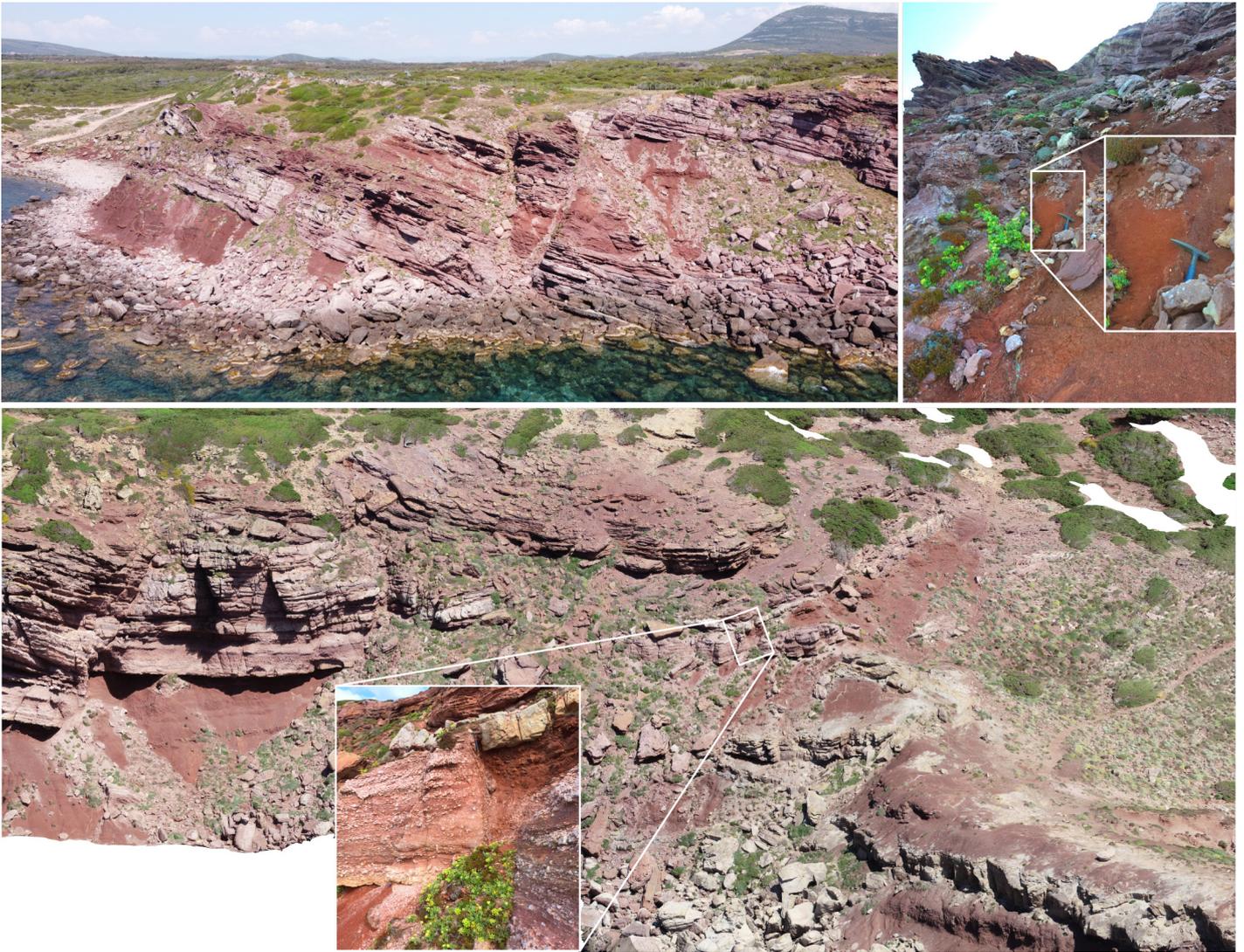


Figure 10

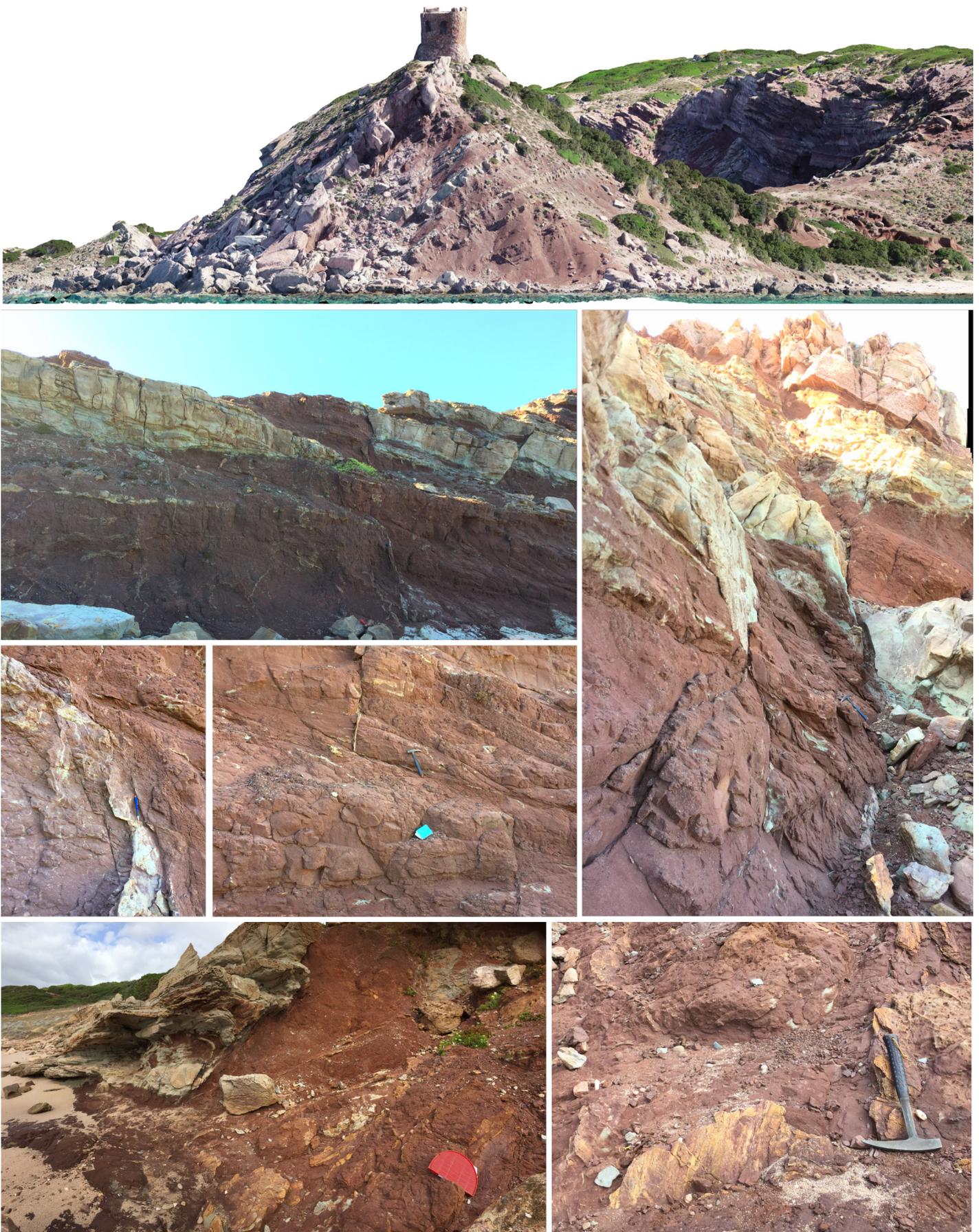


Figure 11

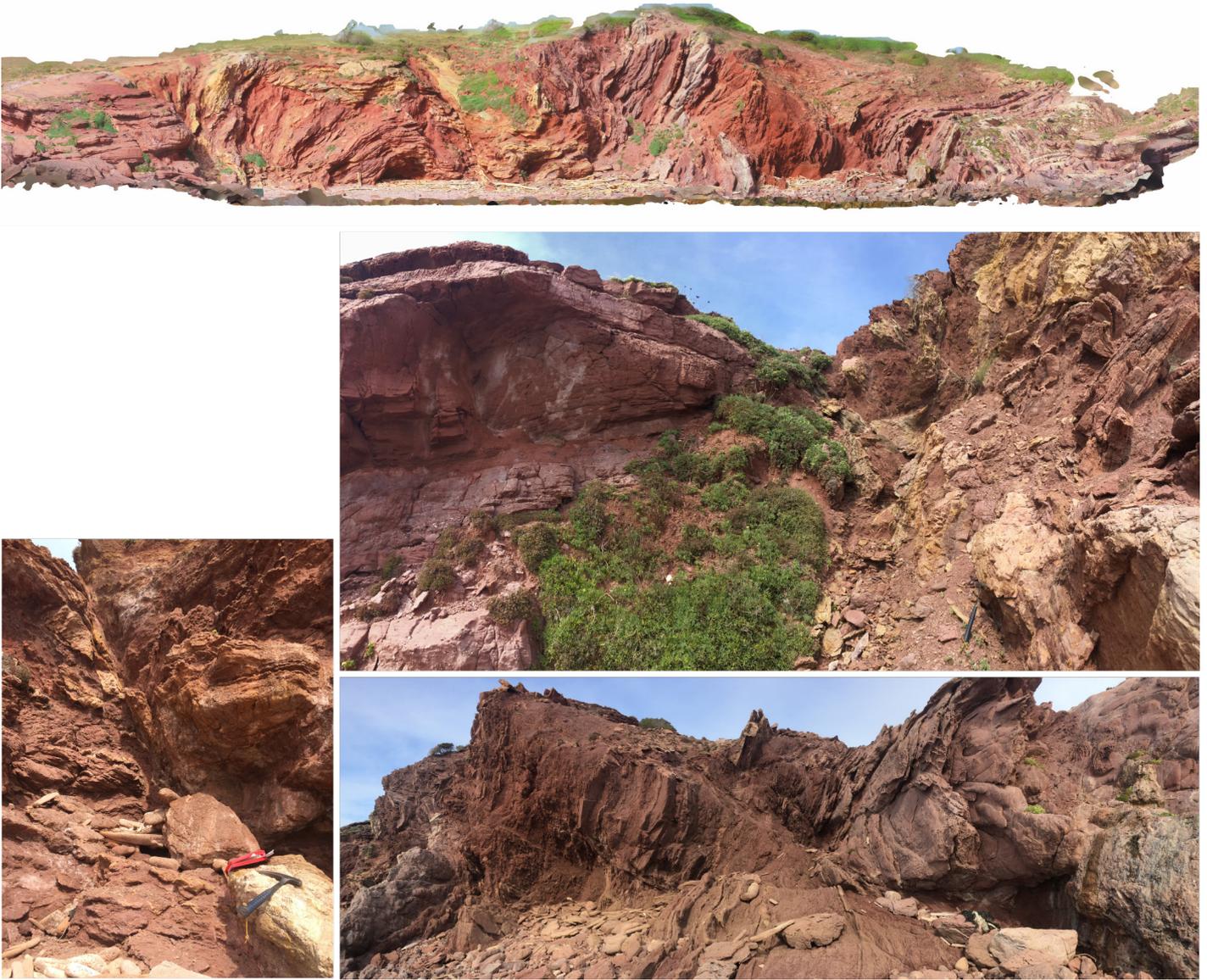


Figure 12



Figure 13