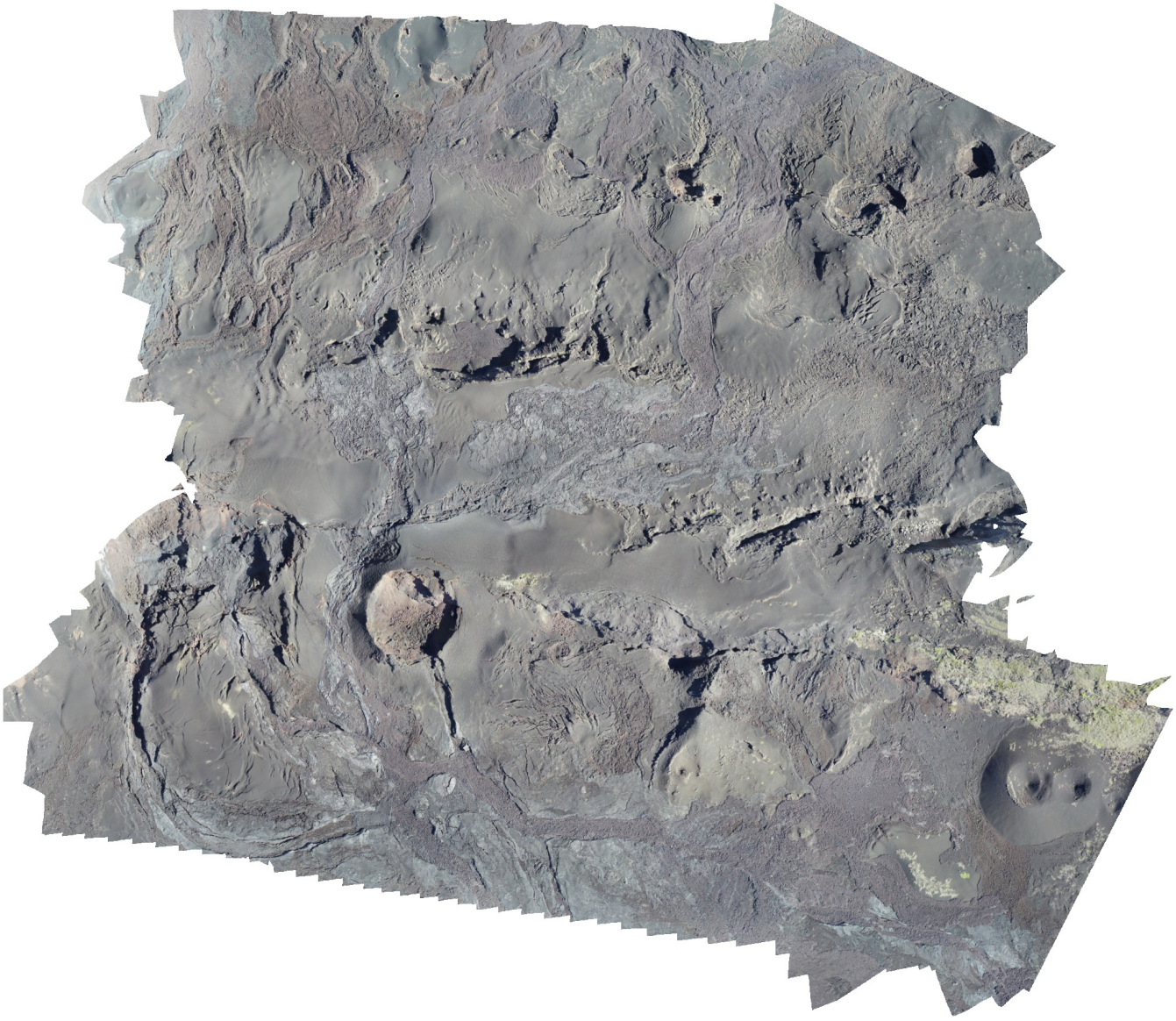
Galapagos Thermal Inertia Flights

Processing Report
Flight 2 Visual

Sierra Negra Volcano
Isla Isabela, Galapagos Islands
October 22, 2018
DJI M210 UAS
Zenmuse X4S Visual Camera

07 July 2020



Survey Data

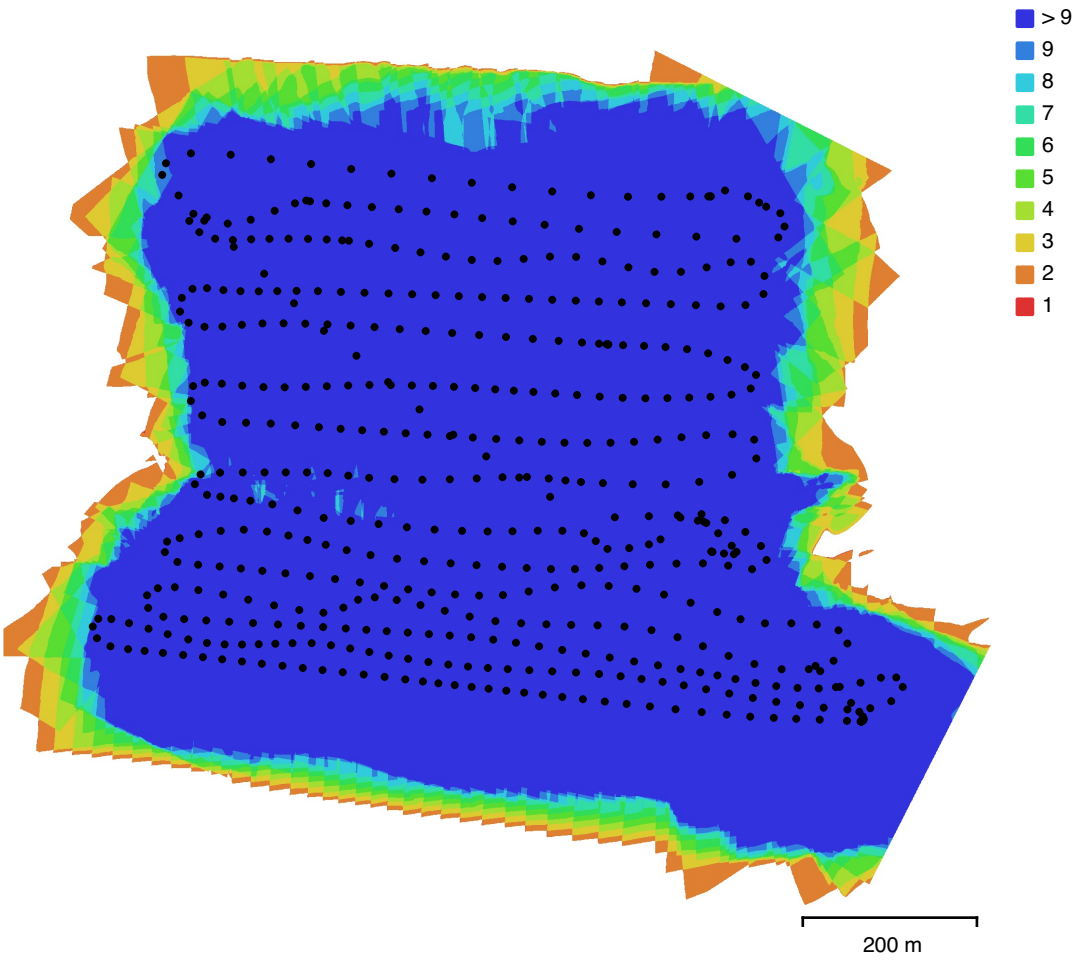


Fig. 1. Camera locations and image overlap.

Number of images:	487	Camera stations:	487
Flying altitude:	162 m	Tie points:	4,801,557
Ground resolution:	4.05 cm/pix	Projections:	17,593,547
Coverage area:	0.784 km²	Reprojection error:	0.514 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6510 (8.8mm)	5472 x 3078	8.8 mm	2.53 x 2.53 µm	No

Table 1. Cameras.

Camera Calibration

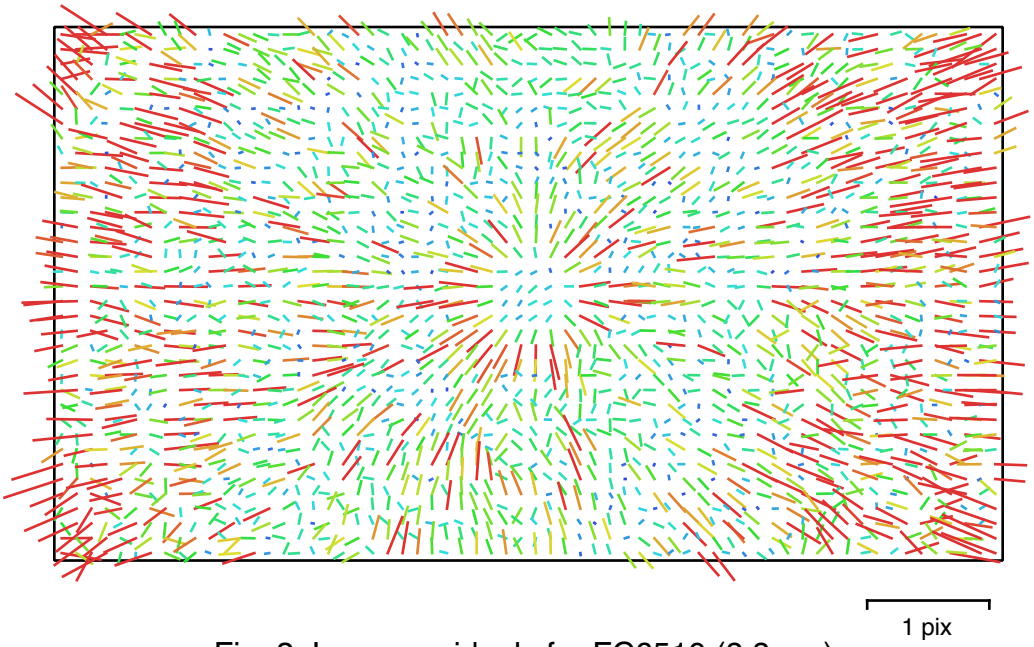


Fig. 2. Image residuals for FC6510 (8.8mm).

FC6510 (8.8mm)
487 images

Type	Resolution	Focal Length	Pixel Size
Frame	5472 x 3078	8.8 mm	2.53 x 2.53 µm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2
F	3674.64	0.056	1.00	0.23	-0.98	0.77	0.06	0.11	-0.05	0.08	-0.11	0.11	-0.36
Cx	13.9091	0.0062		1.00	-0.24	0.19	0.28	0.02	-0.01	0.01	-0.02	0.81	-0.09
Cy	23.7416	0.032			1.00	-0.80	-0.06	-0.14	0.08	-0.11	0.13	-0.11	0.35
B1	-7.31001	0.0045				1.00	0.09	0.01	-0.08	0.10	-0.12	0.04	0.10
B2	0.187271	0.002					1.00	-0.02	0.00	0.00	-0.00	0.09	0.05
K1	0.0193071	1.2e-05						1.00	-0.94	0.89	-0.84	0.04	-0.29
K2	-0.0957351	6.2e-05							1.00	-0.99	0.96	0.00	0.03
K3	0.180673	0.00013								1.00	-0.99	0.00	-0.03
K4	-0.114172	9.3e-05									1.00	-0.00	0.04
P1	0.00179014	4.7e-07										1.00	-0.16
P2	0.000271095	1e-06											1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

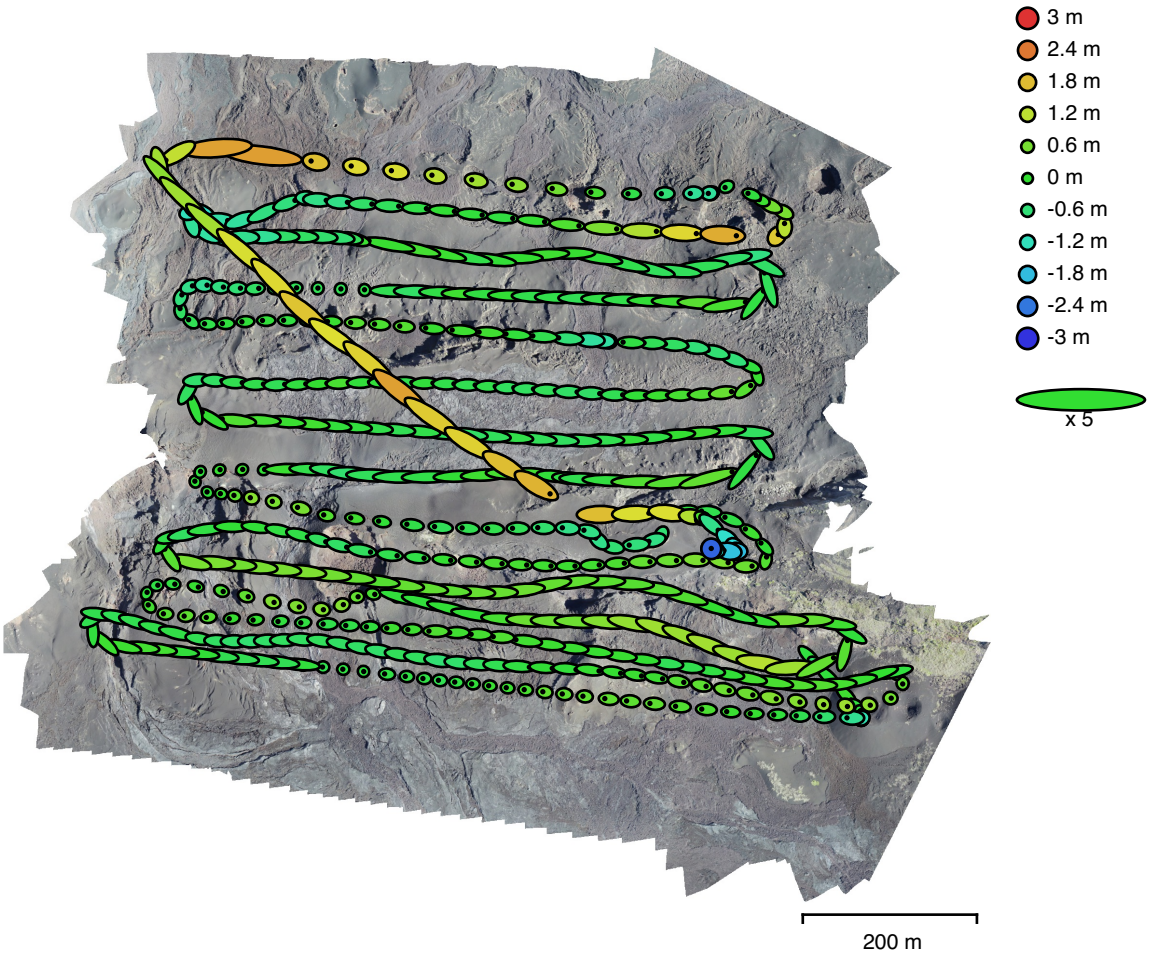


Fig. 3. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
5.10867	1.58163	0.613988	5.3479	5.38303

Table 3. Average camera location error.
X - Easting, Y - Northing, Z - Altitude.

Ground Control Points

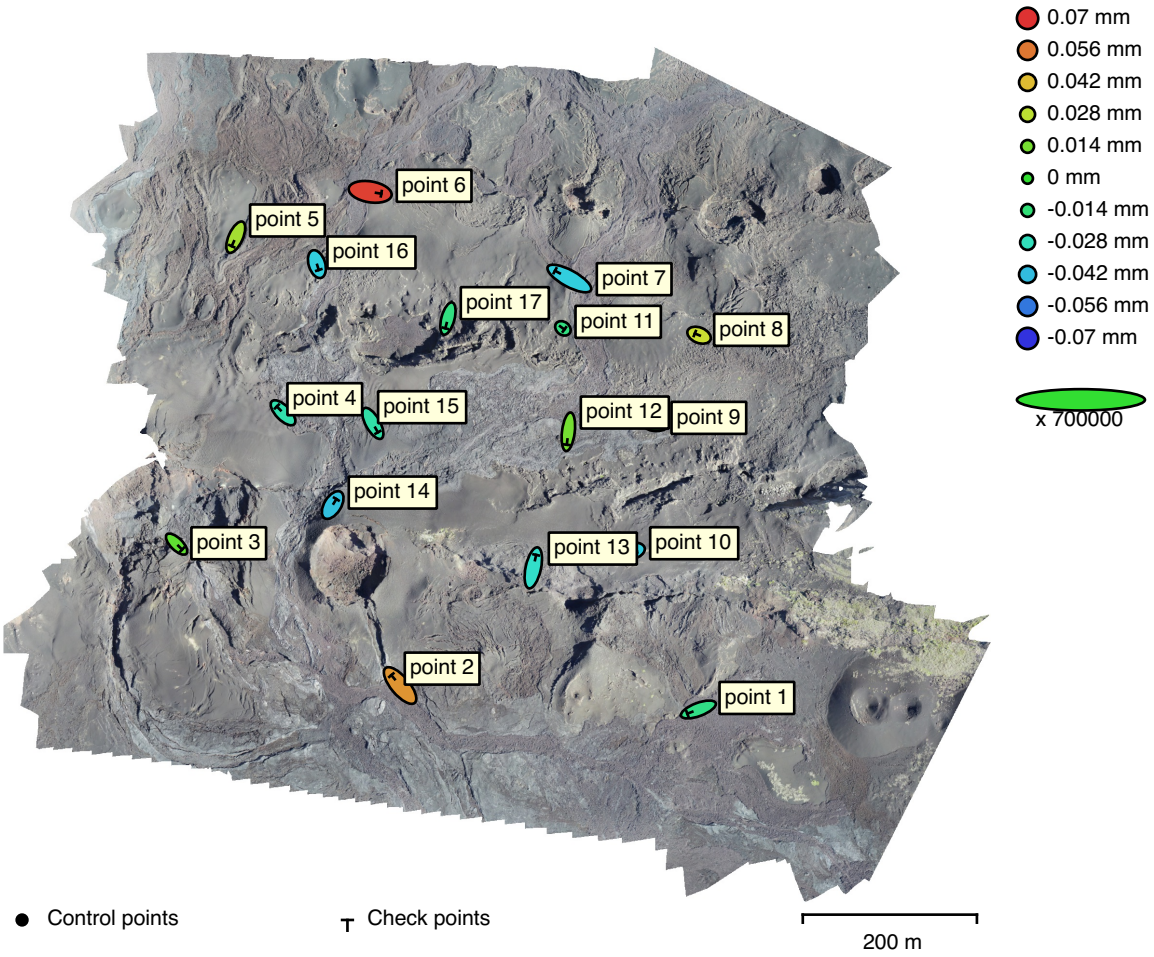


Fig. 4. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (mm)	Y error (mm)	Z error (mm)	XY error (mm)	Total (mm)
17	0.0220435	0.0242092	0.0323682	0.0327414	0.0460402

Table 4. Check points RMSE.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (mm)	Y error (mm)	Z error (mm)	Total (mm)	Image (pix)
point 1	-0.0364698	-0.0135826	-0.0171502	0.0425283	0.004 (33)
point 2	-0.0286768	0.0340132	0.0500927	0.0669965	0.004 (35)
point 3	0.018096	-0.0177606	0.00926136	0.026994	0.003 (21)
point 4	-0.020154	0.0206121	-0.0249944	0.0381544	0.003 (15)
point 5	-0.013189	-0.0294142	0.0230307	0.0396177	0.003 (26)
point 6	0.0365075	-0.00601174	0.0671635	0.0766804	0.003 (20)
point 7	-0.0469638	0.0256142	-0.0381146	0.0656842	0.003 (27)
point 8	-0.0139234	0.00562331	0.0312087	0.0346333	0.003 (20)
point 9	0.0208814	0.000429015	-0.00111287	0.0209155	0.003 (20)
point 10	0.0190711	0.00447585	-0.0388398	0.0435003	0.004 (19)
point 11	0.00488601	-0.00358608	-0.0159197	0.0170343	0.003 (25)
point 12	-0.00512397	-0.042529	0.0135821	0.0449383	0.004 (17)
point 13	0.00924911	0.0425103	-0.0308295	0.053321	0.003 (18)
point 14	0.0120407	0.0195224	-0.0409854	0.0469671	0.003 (8)
point 15	0.0166069	-0.0293928	-0.023664	0.0412276	0.004 (16)
point 16	0.006154	-0.0192913	-0.0379121	0.0429809	0.004 (27)
point 17	-0.00861843	-0.0320403	-0.0159277	0.0368042	0.003 (19)
Total	0.0220435	0.0242092	0.0323682	0.0460402	0.003

Table 5. Check points.
X - Easting, Y - Northing, Z - Altitude.

Digital Elevation Model

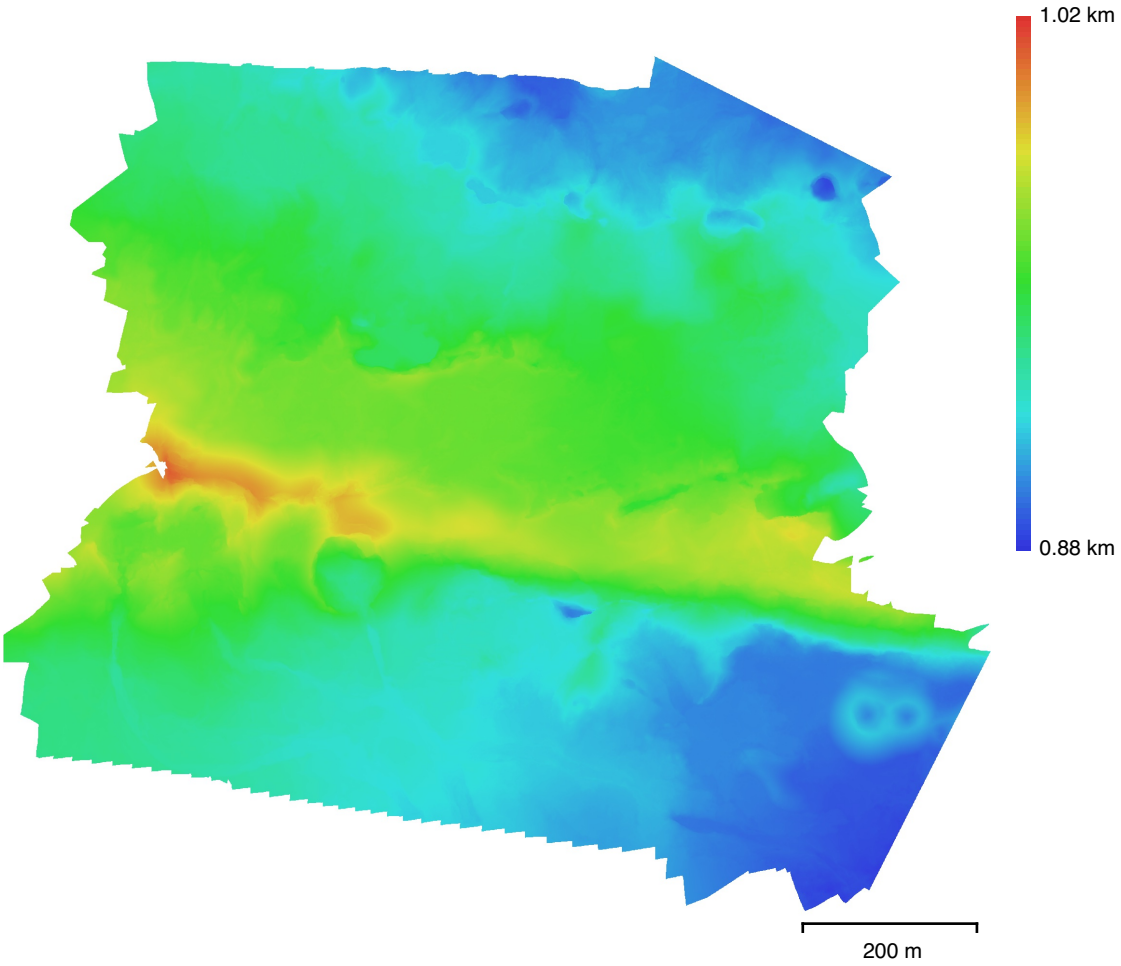


Fig. 5. Reconstructed digital elevation model.

Resolution:	8.1 cm/pix
Point density:	153 points/m²

Processing Parameters

General	
Cameras	487
Aligned cameras	487
Markers	17
Coordinate system	WGS 84 / UTM zone 15S (EPSG::32715)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	4,801,557 of 5,721,211
RMS reprojection error	0.1692 (0.514271 pix)
Max reprojection error	0.540514 (7.5856 pix)
Mean key point size	2.98067 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	3.95115
Alignment parameters	
Accuracy	High
Generic preselection	No
Reference preselection	Yes
Key point limit	0
Tie point limit	0
Matching time	1 hours 3 minutes
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	1 minutes 41 seconds
Dense Point Cloud	
Points	161,460,941
Point colors	3 bands, uint8
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	11 hours 4 minutes
Dense cloud generation parameters	
Processing time	1 hours 21 minutes
Model	
Faces	32,292,144
Vertices	16,154,379
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense cloud
Interpolation	Enabled
Processing time	3 hours 10 minutes
Texturing parameters	
Mapping mode	Generic
Blending mode	Mosaic
Texture size	4,096

General	
Enable hole filling	Yes
Enable ghosting filter	No
UV mapping time	7 minutes 15 seconds
Blending time	4 minutes 12 seconds
DEM	
Size	19,037 x 18,151
Coordinate system	WGS 84 (EPSG::4326)
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	3 minutes 17 seconds
Orthomosaic	
Size	27,994 x 24,278
Coordinate system	WGS 84 (EPSG::4326)
Colors	3 bands, uint8
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	28 minutes 49 seconds
System	
Software name	Agisoft Metashape Professional
Software version	1.6.1 build 10009
OS	Mac OS 64 bit
RAM	16.00 GB
CPU	Intel(R) Core(TM) i7-4870HQ CPU @ 2.50GHz
GPU(s)	None