Metadata Report

Project Name: *Digital Elevation Model of Crater Elegante, Sonora, Mexico, November 2022*

Summary

Digital surface model and orthoimage for Crater Elegante derived from photogrammetry using UAS-collected photography and is tiled in 1 km^2 blocks. The model is useful for mapping this explosive volcanic structure and the surrounding deposits. The coordinate system is in decimal degrees.

Personnel

- PI(s): Dr. Laura Kerber, Prof. Ramon Arrowsmith
- Field staff: Dr. Rebecca Greenberg, Prof. Amanda Clarke
- Additional team members: Elisheva Sherman, Madeline Schwarz, Tasha Coelho

Site Information

- Site description: Crater Elegante maar volcano and surrounding pyroclastic deposits.
- Site objective: High-resolution digital elevation model for geologic mapping
- Site Location: 31.852097, -113.388025
- Site conditions: Good
- Site data collection (date/time):11/06/2022 8:00 am to 4:00 pm

Survey Results

- Equipment used: DJI Phantom 4 Pro
- GPS solutions: single-channel GNSS on board the UAS.
- Errors: X error (m): 0.422793, Y error (m): 0.619202, Z error (m): 1.06926, XY error (m): 0.749777, Total error (m): 1.30594
- Alignments: 2790/2802 cameras
- Collection methods: DJI Phantom 4 Pro

Products

- Date of dataset collection: 11/06/2022
- Coordinate system of datasets: WGS 84 (EPSG:4326)
- Spatial resolution: 16.7 cm/pix
- Horizontal Accuracy: 1.306 m- latitude & longitude
- Vertical Accuracy: ~16m -SRTM from the same latitude & longitude
- Data formats: GeoTIFF
- Data processing methods: Agisoft Metashape and ArcGIS Pro

Misc Notes

Dataset Information:
These raster datasets over Crater Elegante, which was formed in an explosive phreatomagmatic eruption of 42-36 ka in what is now the Biosphere Reserve Pinacate, Sonora, Mexico. The Digital Surface Models (DSM) were produced by capturing low-altitude aerial photographs, ranging between 35 to 120 meters, using an unmanned aerial vehicle (UAV). The UAV drone models employed were the DJI Phantom 4 Pro, equipped with a camera and built-in global navigation satellite system (GNSS) capabilities with an accuracy of 10 meters. These cameras had 5472 x 3648-pixel resolution.

After the initial creation of the model, there was a long-wave error with the northwest corner of the DSM being ~40 m lower in elevation than the southeast corner. This was manually corrected by using the Shuttle Radar Topography Mission (SRTM) UTM of the region to get the true elevation point of 13 evenly distributed points and snapping the model to these ground control points within Agisoft Metashape. I also manually verified the locations of these 26 markers through 100's of photos.

Crater Elegante Report

Processing Report

01 December 2025

Survey Data

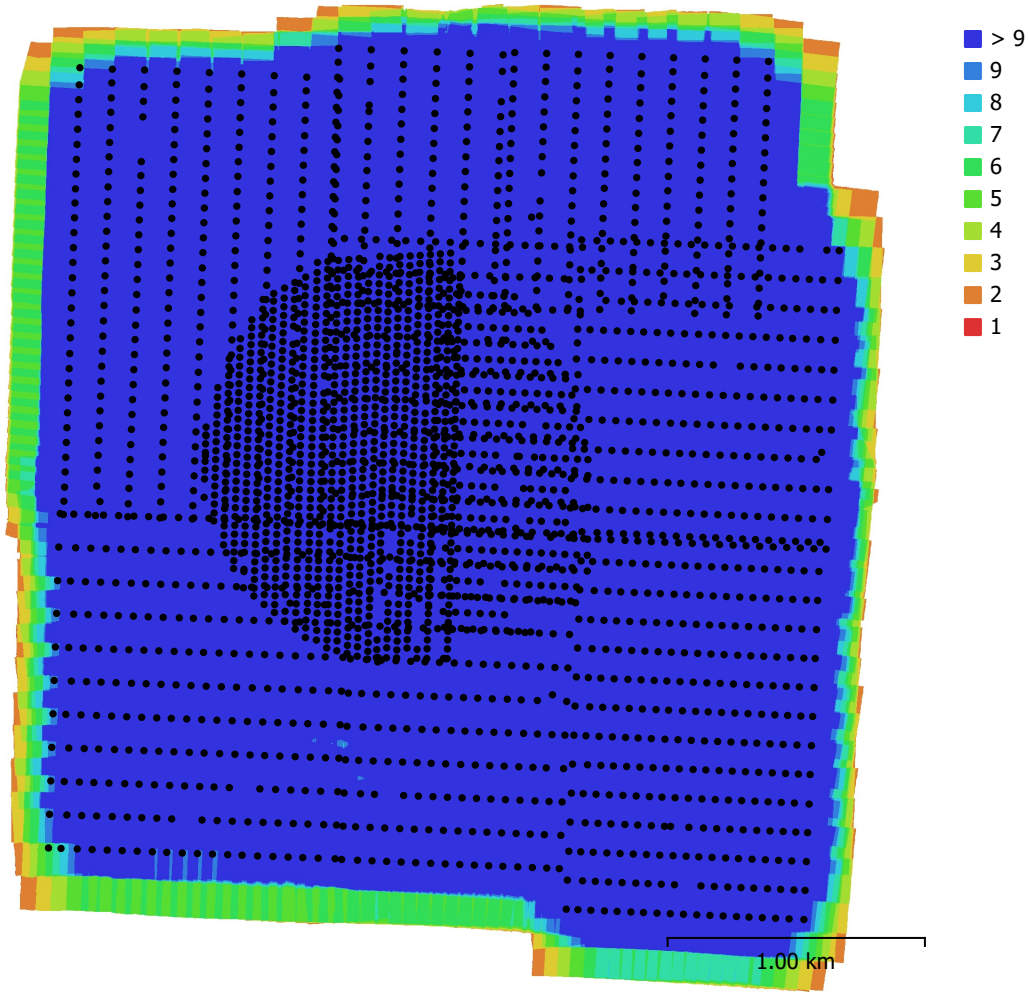


Fig. 1. Camera locations and image overlap.

Number of images:	2,802	Camera stations:	2,790
Flying altitude:	318 m	Tie points:	1,251,150
Ground resolution:	8.36 cm/pix	Projections:	9,649,885
Coverage area:	11.8 km²	Reprojection error:	1.16 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6310 (8.8mm)	5472 x 3648	8.8 mm	2.41 x 2.41 µm	No

Table 1. Cameras.

Camera Calibration

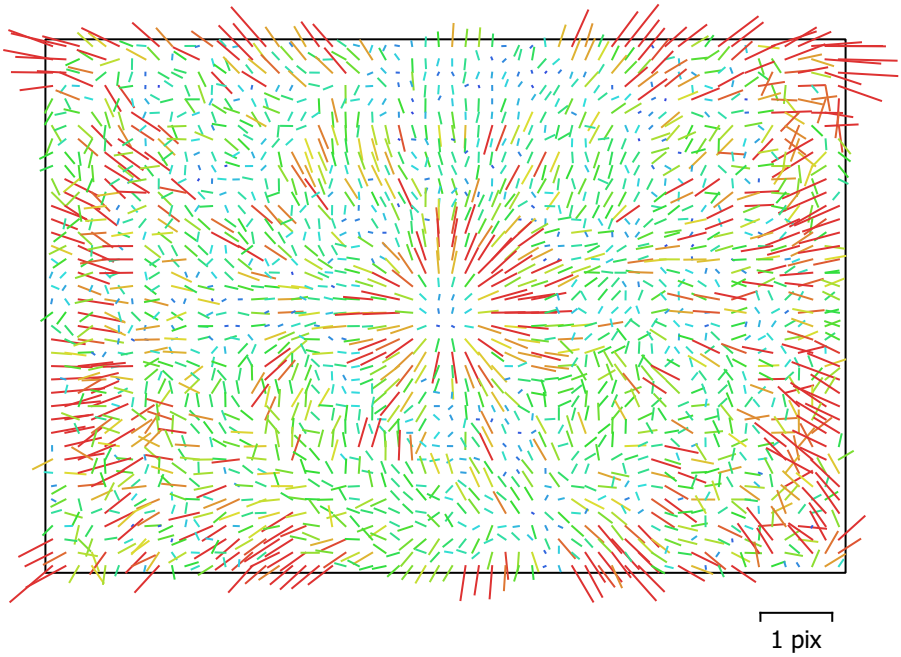


Fig. 2. Image residuals for FC6310 (8.8mm).

FC6310 (8.8mm)

2802 images

Type	Resolution	Focal Length	Pixel Size
Frame	**5472 x 3648**	**8.8 mm**	**2.41 x 2.41 µm**

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	**3688.04**	0.037	1.00	0.03	-0.43	-0.20	0.19	-0.16	0.03	-0.08
Cx	**49.1435**	0.023		1.00	-0.01	0.01	-0.01	0.01	0.73	-0.04
Cy	**28.4637**	0.022			1.00	-0.01	-0.00	0.00	-0.03	0.50
K1	**0.00737188**	2.4e-05				1.00	-0.97	0.91	0.03	-0.00
K2	**-0.00870658**	7.3e-05					1.00	-0.98	-0.03	-0.01
K3	**0.00950447**	6.7e-05						1.00	0.03	0.00
P1	**0.00338251**	1.7e-06							1.00	-0.04
P2	**0.00152836**	1.3e-06								1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Orientations

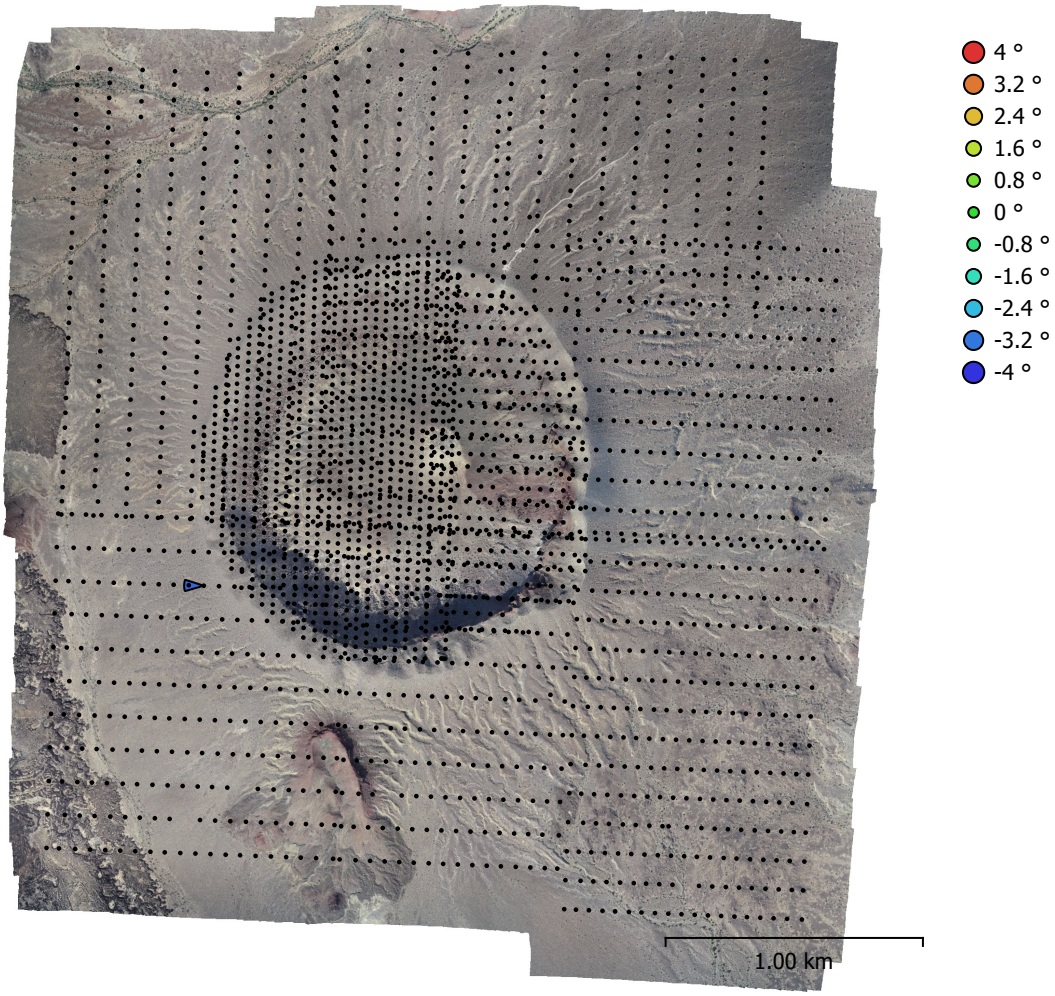


Fig. 3. Camera orientations and error estimates.
Arcs represent yaw error estimates.

Yaw error (°)	Pitch error (°)	Roll error (°)	Total error (°)
3.37169	0.312171	0.630506	3.44431

Table 3. Average camera rotation error.

Ground Control Points

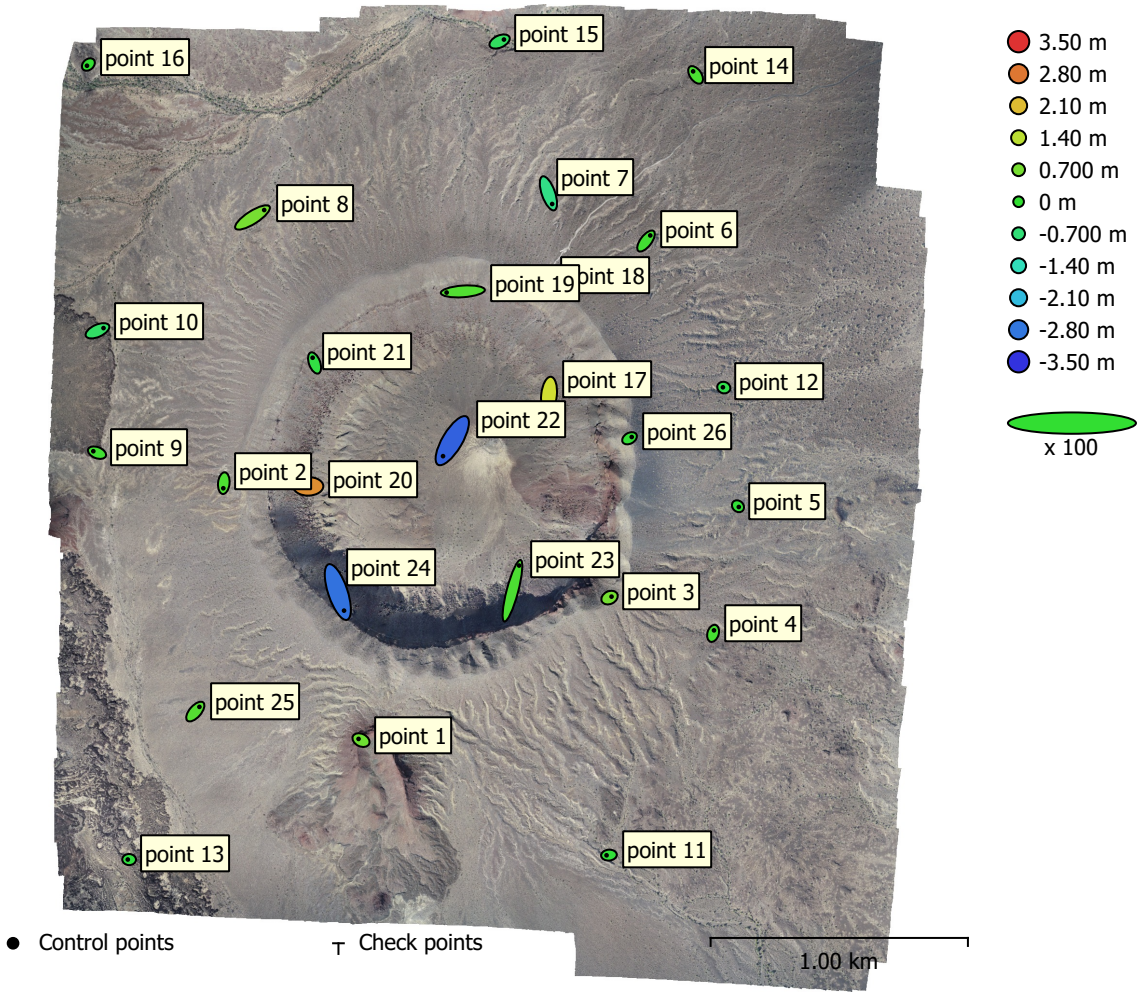


Fig. 4. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (m)	Y error (m)	Z error (m)	XY error (m)	Total (m)
26	0.422793	0.619202	1.06926	0.749777	1.30594

Table 4. Control points RMSE.
X - Longitude, Y - Latitude, Z - Altitude.

Label	X error (m)	Y error (m)	Z error (m)	Total (m)	Image (pix)
point 1	-0.191752	0.0926567	0.610038	0.646143	86.262 (11)
point 2	-0.0378407	-0.394932	0.274399	0.482388	39.039 (25)
point 3	0.154886	0.0757561	0.674805	0.696484	38.378 (18)
point 4	0.0697234	0.232172	0.200985	0.314897	25.594 (22)
point 5	0.0646074	-0.058338	-0.0582816	0.104758	19.787 (26)
point 6	0.32914	0.431515	0.159527	0.565674	40.483 (33)
point 7	0.291579	-0.829631	-0.850697	1.22352	72.245 (24)
point 8	0.908348	0.57935	0.699399	1.28448	73.494 (18)
point 9	-0.287275	0.111619	0.151428	0.343389	28.711 (10)
point 10	0.467757	0.210961	-0.521569	0.731666	99.328 (9)
point 11	-0.18631	-0.0151317	-0.0744409	0.201201	22.368 (25)
point 12	-0.0686299	0.0215671	-0.250699	0.260817	29.502 (23)
point 13	-0.103232	0.00334559	-0.141598	0.175265	36.815 (11)
point 14	-0.191364	0.273443	0.253028	0.418825	36.123 (16)
point 15	0.337474	0.154032	-0.451856	0.584627	109.231 (10)
point 16	-0.109119	-0.0949644	0.00987655	0.144992	45.622 (3)
point 17	-0.0853053	-0.812197	1.62276	1.81667	29.719 (86)
point 18	-0.276421	-0.0635137	0.272467	0.393295	21.297 (33)
point 19	-1.26061	-0.0890656	0.321711	1.30406	14.423 (71)
point 20	-0.447424	-0.00769229	2.56718	2.60589	28.590 (124)
point 21	-0.150649	0.406378	-0.17693	0.468127	98.587 (37)
point 22	-0.717985	-1.20453	-3.02592	3.33505	23.879 (254)
point 23	0.518823	1.96122	0.262243	2.04556	61.701 (136)
point 24	0.483073	-1.44565	-2.84756	3.22984	80.868 (37)
point 25	0.318578	0.363459	0.349963	0.596714	47.279 (18)
point 26	0.169945	0.0981982	-0.0302767	0.198597	28.254 (20)
Total	**0.422793**	**0.619202**	**1.06926**	**1.30594**	**45.387**

Table 5. Control points.

X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

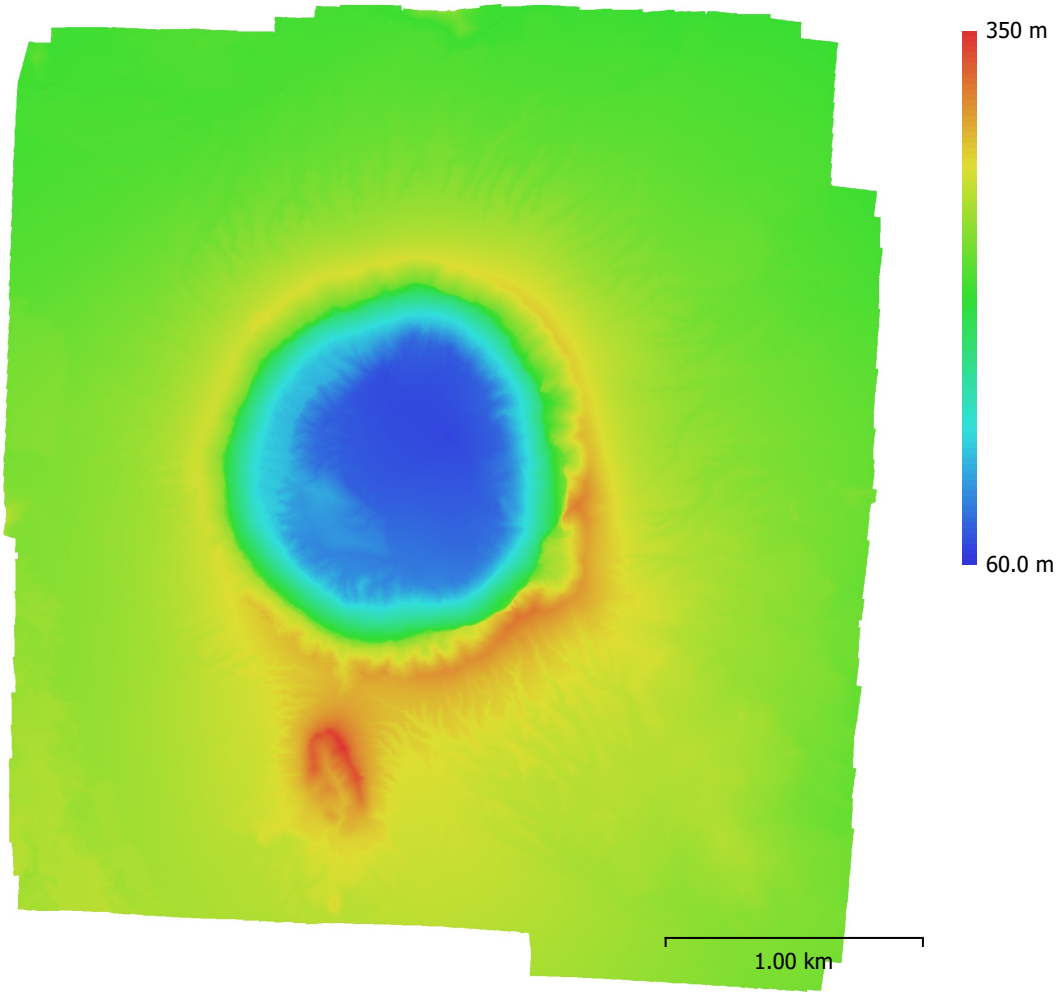


Fig. 5. Reconstructed digital elevation model.

Resolution:	16.7 cm/pix
Point density:	35.8 points/m²

Processing Parameters

General	
Images	2802
Aligned images	2790
Markers	26
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Tie Points	
Points	1,251,150 of 1,395,131
RMS reprojection error	0.564541 (1.16485 pix)
Max reprojection error	28.5939 (73.5514 pix)
Mean key point size	2.06669 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	9.62695
Alignment parameters	
Accuracy	Highest
Generic preselection	Yes
Reference preselection	Source
Key point limit	40,000
Key point limit per Mpx	1,000
Tie point limit	4,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	31 minutes 8 seconds
Matching memory usage	3.72 GB
Alignment time	16 minutes 8 seconds
Alignment memory usage	4.71 GB
Optimization parameters	
Parameters	f, cx, cy, k1-k3, p1, p2
Adaptive camera model fitting	No
Exclude corners	No
Optimization time	44 seconds
Date created	2022:11:08 22:45:09
Software version	1.8.4.14856
File size	237.93 MB
Point Cloud	
Points	559,814,455
Point attributes	
Color	3 bands, uint8
Normal	
Confidence	1 - 181
Point classes	
Created (never classified)	559,814,455
Depth maps generation parameters	
Quality	High
Filtering mode	Moderate
Max neighbors	16
Processing time	2 hours 36 minutes
Memory usage	9.09 GB

Point cloud generation parameters	
Processing time	5 hours 3 minutes
Memory usage	43.73 GB
Date created	2024:05:22 17:54:21
Software version	1.8.4.14856
File size	7.91 GB
Model	
Faces	115,966,343
Vertices	57,924,434
Vertex colors	3 bands, uint8
Texture	8,192 x 8,192, 3 bands, uint8
Depth maps generation parameters	
Quality	High
Filtering mode	Moderate
Max neighbors	16
Processing time	2 hours 36 minutes
Memory usage	9.09 GB
Reconstruction parameters	
Surface type	Arbitrary
Source data	Point cloud
Interpolation	Enabled
Strict volumetric masks	No
Processing time	59 minutes 44 seconds
Memory usage	21.32 GB
Texturing parameters	
Mapping mode	Orthophoto
Blending mode	Mosaic
Texture size	8,192
Page count	1
Enable hole filling	Yes
Enable ghosting filter	Yes
UV mapping time	3 minutes 6 seconds
UV mapping memory usage	10.41 GB
Blending time	28 minutes 38 seconds
Blending memory usage	19.53 GB
Date created	2024:05:22 22:53:37
Software version	1.8.4.14856
File size	5.24 GB
Tiled Model	
Texture	3 bands, uint8
Depth maps generation parameters	
Quality	High
Filtering mode	Moderate
Max neighbors	16
Processing time	2 hours 36 minutes
Memory usage	9.09 GB
Reconstruction parameters	
Source data	Point cloud
Tile size	256
Face count	Medium
Enable ghosting filter	No
Processing time	2 hours 18 minutes
Memory usage	15.97 GB
Date created	2024:05:23 10:01:05
Software version	1.8.4.14856
File size	2.97 GB

DEM

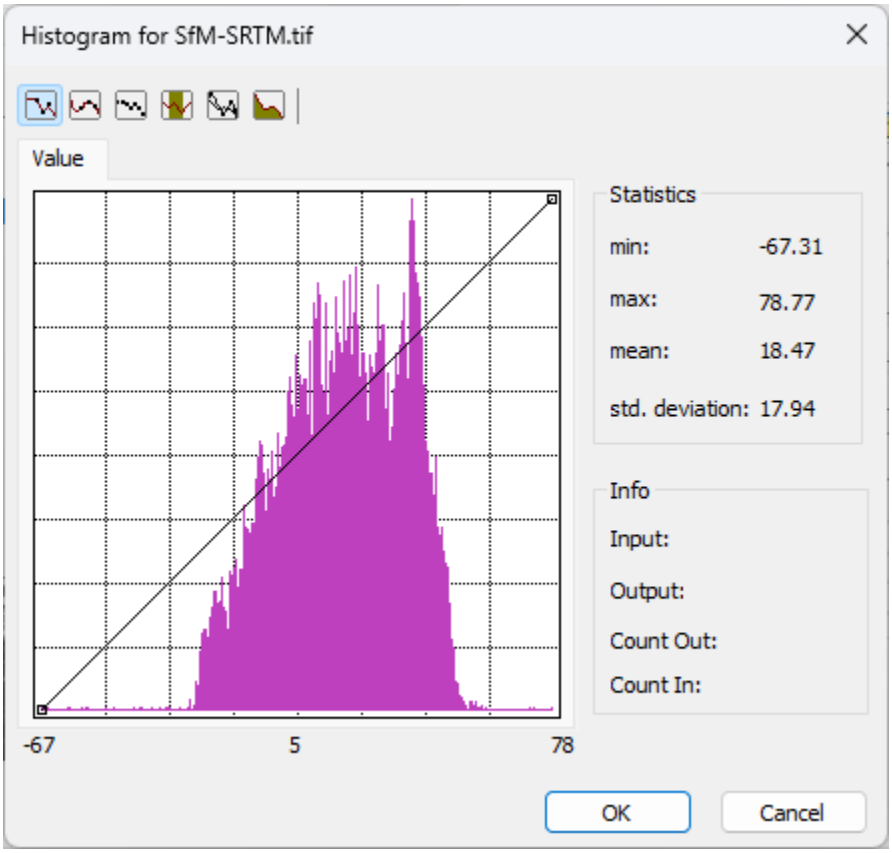
Size	31,048 x 32,011
Resolution	16.7 cm/pix
Coordinate system	WGS 84 (EPSG::4326)
Reconstruction parameters	
Source data	Point cloud
Interpolation	Enabled
Processing time	3 minutes 9 seconds
Memory usage	360.49 MB
Date created	2024:05:23 11:03:42
Software version	1.8.4.14856
File size	1.62 GB

Orthomosaic

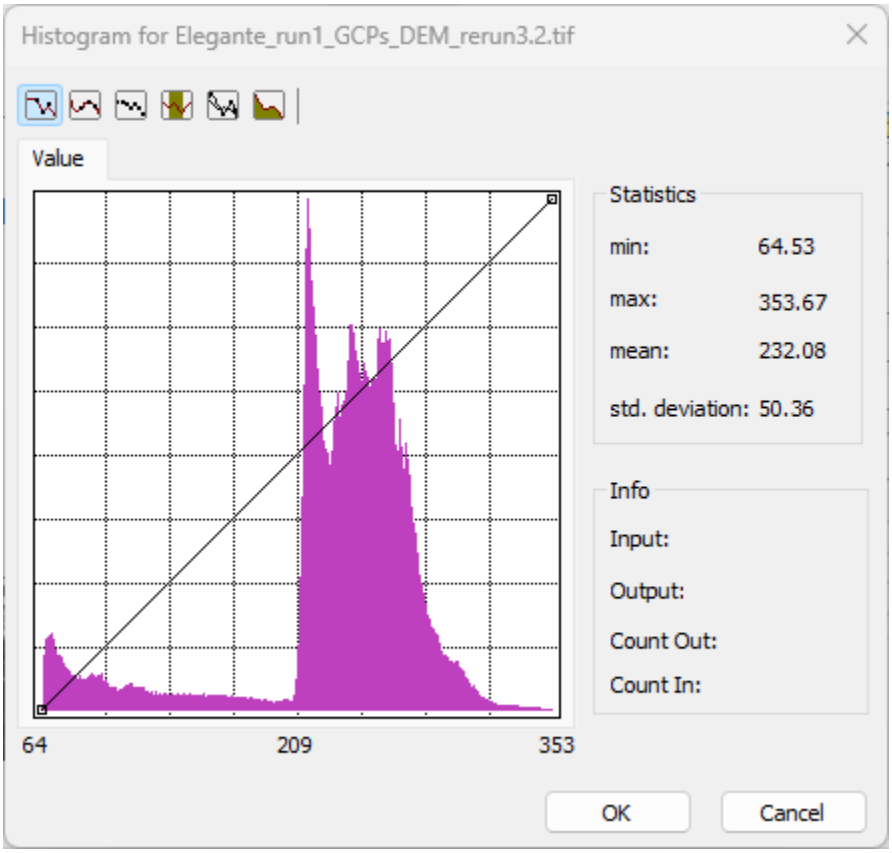
Size	40,850 x 45,878
Resolution	8.36 cm/pix
Coordinate system	WGS 84 (EPSG::4326)
Colors	3 bands, uint8
Orthophotos	64.42 GB
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Enable ghosting filter	No
Processing time	28 minutes 25 seconds
Memory usage	3.71 GB
Date created	2024:05:23 11:28:01
Software version	1.8.4.14856
File size	66.57 GB

System

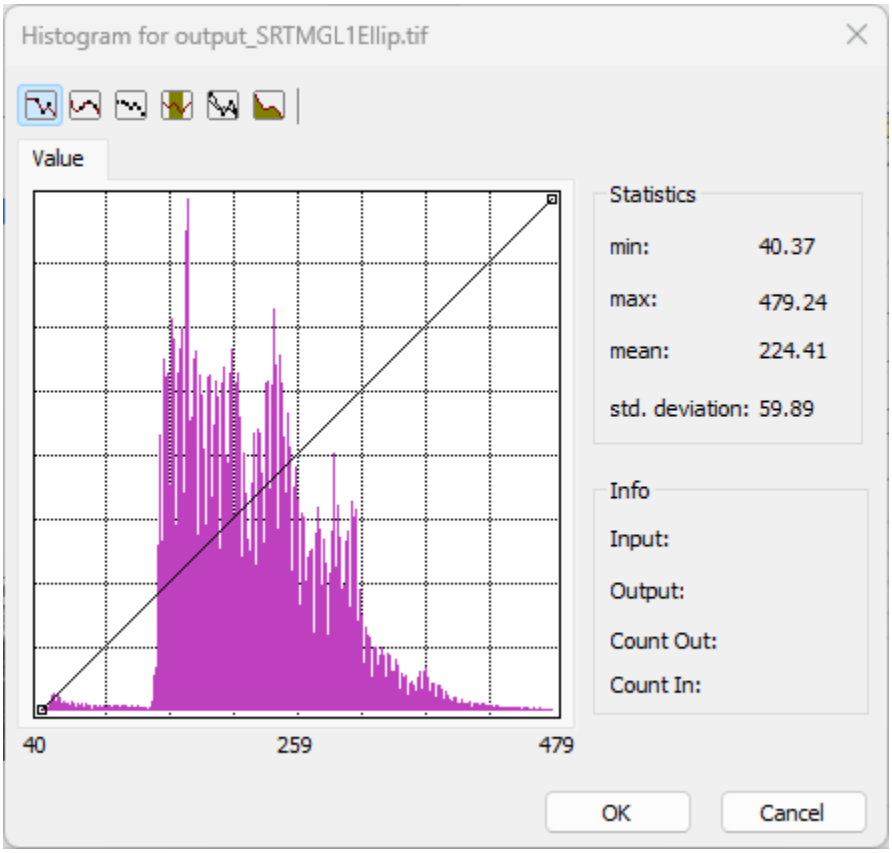
Software name	Agisoft Metashape Professional
Software version	2.2.1 build 20641
OS	Windows 64 bit
RAM	93.64 GB
CPU	AMD Ryzen 9 9950X 16-Core Processor
GPU(s)	NVIDIA GeForce RTX 5090



Histogram for SfM-SRTM: Histogram of the difference between the Crater Elegante model DEM and the SRTM from Open Topography.



Histogram for Elegante_run1_GCPs_DEM_rerun3.2: Histogram of the Crater Elegante model DEM.



Histogram for Output_SRTMGLM1Ellip: Histogram of the SRTM from Open Topography.