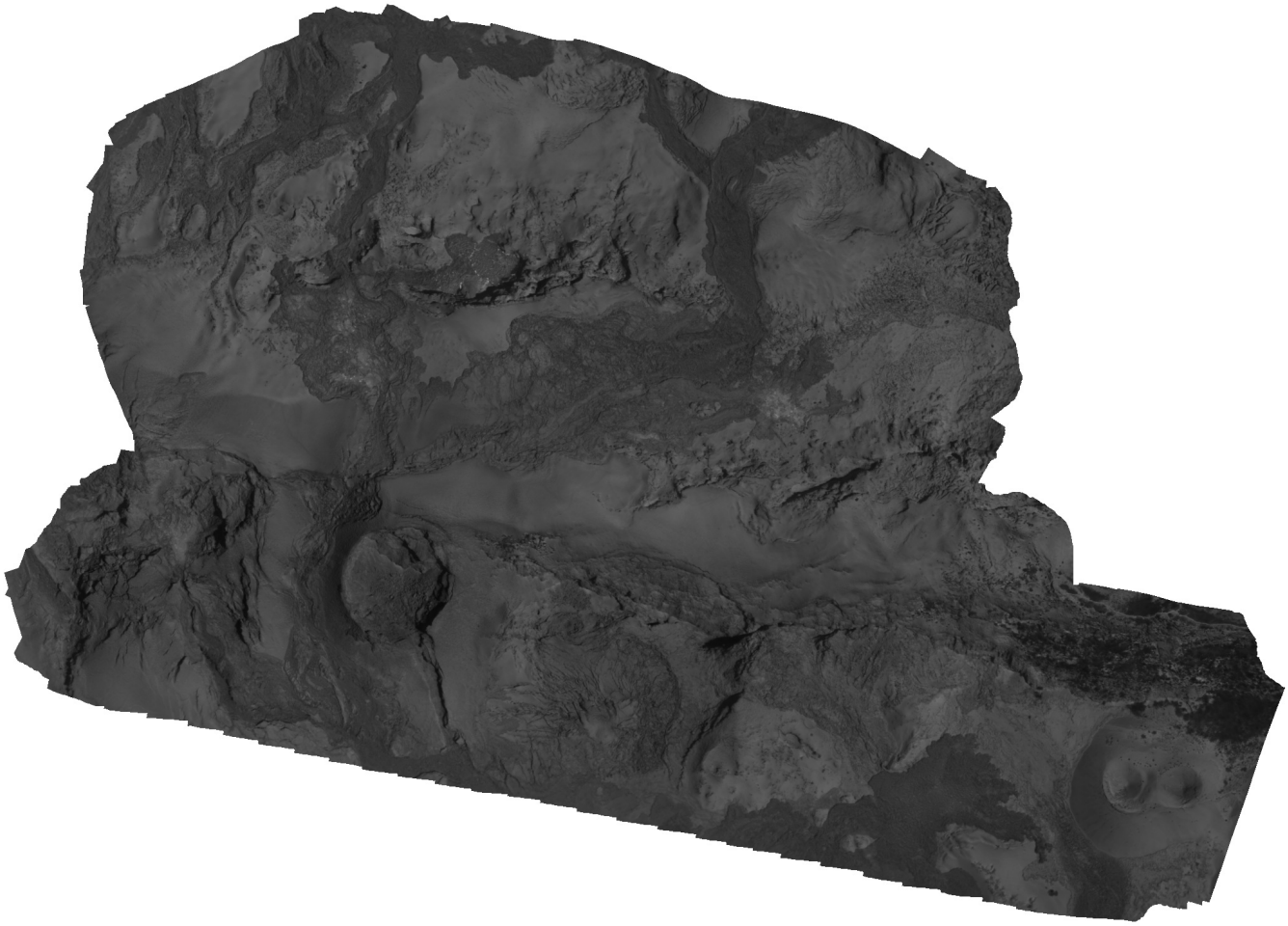
# Galapagos Thermal Inertia Flights

Processing Report
Flight 3 TIR (scaled)

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

01 September 2020



# Survey Data

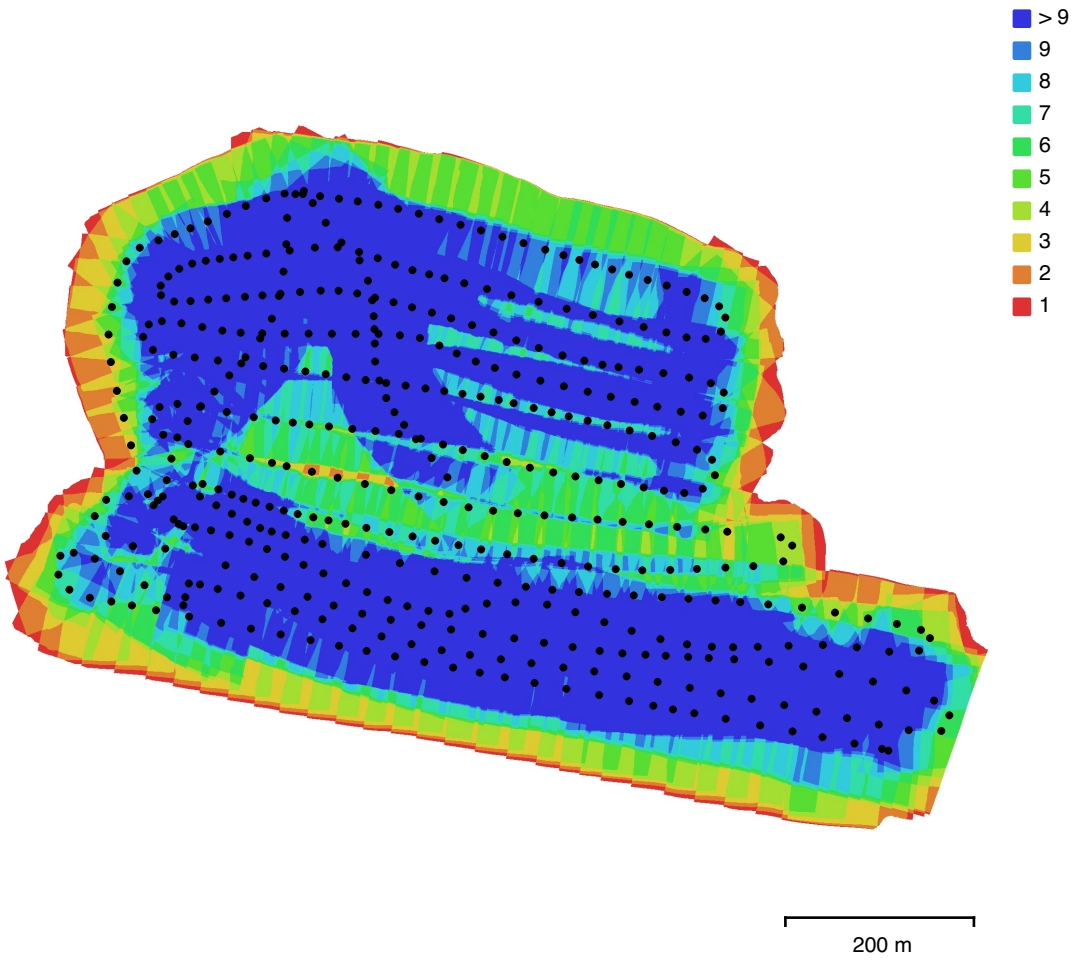



Fig. 1. Camera locations and image overlap.

| | | | |
|---|---|---|---|
| Number of images: | 443 | Camera stations: | 443 |
| Flying altitude: | 141 m | Tie points: | 104,016 |
| Ground resolution: | 17.9 cm/pix | Projections: | 439,137 |
| Coverage area: | 0.502 km² | Reprojection error: | 0.388 pix |

| Camera Model | Resolution | Focal Length | Pixel Size | Precalibrated |
|---|---|---|---|---|
| unknown | 640 x 512 | unknown | unknown | No |

Table 1. Cameras.

# Camera Calibration

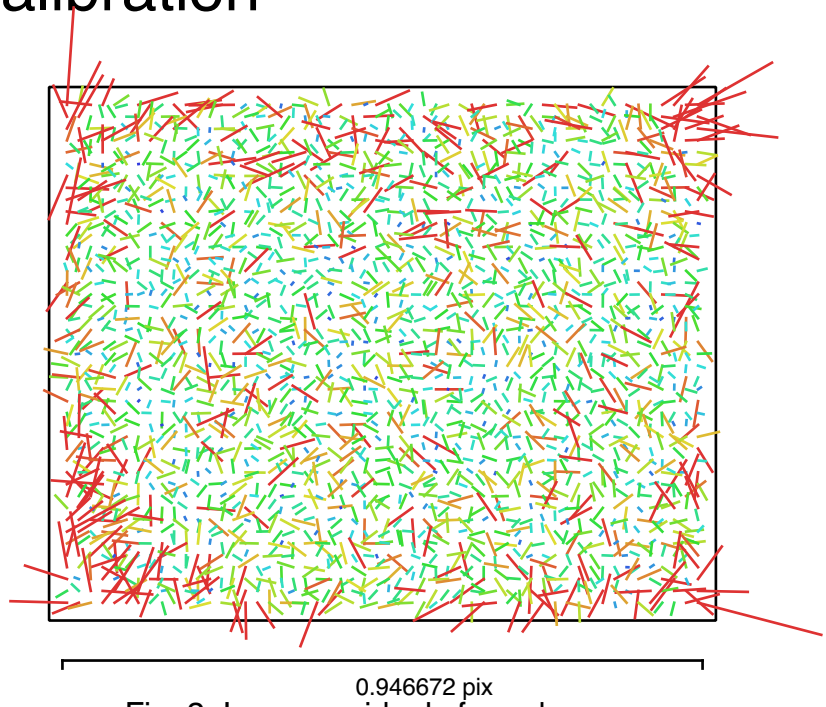



Fig. 2. Image residuals for unknown.

unknown
443 images

| Type | Resolution | Focal Length | Pixel Size |
|---|---|---|---|
| Frame | 640 x 512 | unknown | unknown |

| | Value | Error | F | B1 | B2 | K1 | K2 | K3 | P1 | P2 |
|---|---|---|---|---|---|---|---|---|---|---|
| F | 771.737 | 0.13 | 1.00 | -0.00 | -0.01 | -0.05 | 0.10 | -0.02 | 0.12 | 0.22 |
| B1 | -1.80307 | 0.013 | | 1.00 | -0.08 | -0.27 | -0.01 | -0.01 | 0.24 | 0.62 |
| B2 | 0.125641 | 0.01 | | | 1.00 | 0.07 | -0.00 | 0.01 | -0.21 | -0.15 |
| K1 | -0.0481953 | 0.0006 | | | | 1.00 | -0.88 | 0.84 | -0.17 | -0.43 |
| K2 | 0.242475 | 0.005 | | | | | 1.00 | -0.98 | 0.01 | 0.03 |
| K3 | 0.534392 | 0.014 | | | | | | 1.00 | -0.01 | -0.04 |
| P1 | 0.000194303 | 1.1e-05 | | | | | | | 1.00 | 0.38 |
| P2 | -0.00152756 | 4.3e-05 | | | | | | | | 1.00 |

Table 2. Calibration coefficients and correlation matrix.

# Ground Control Points

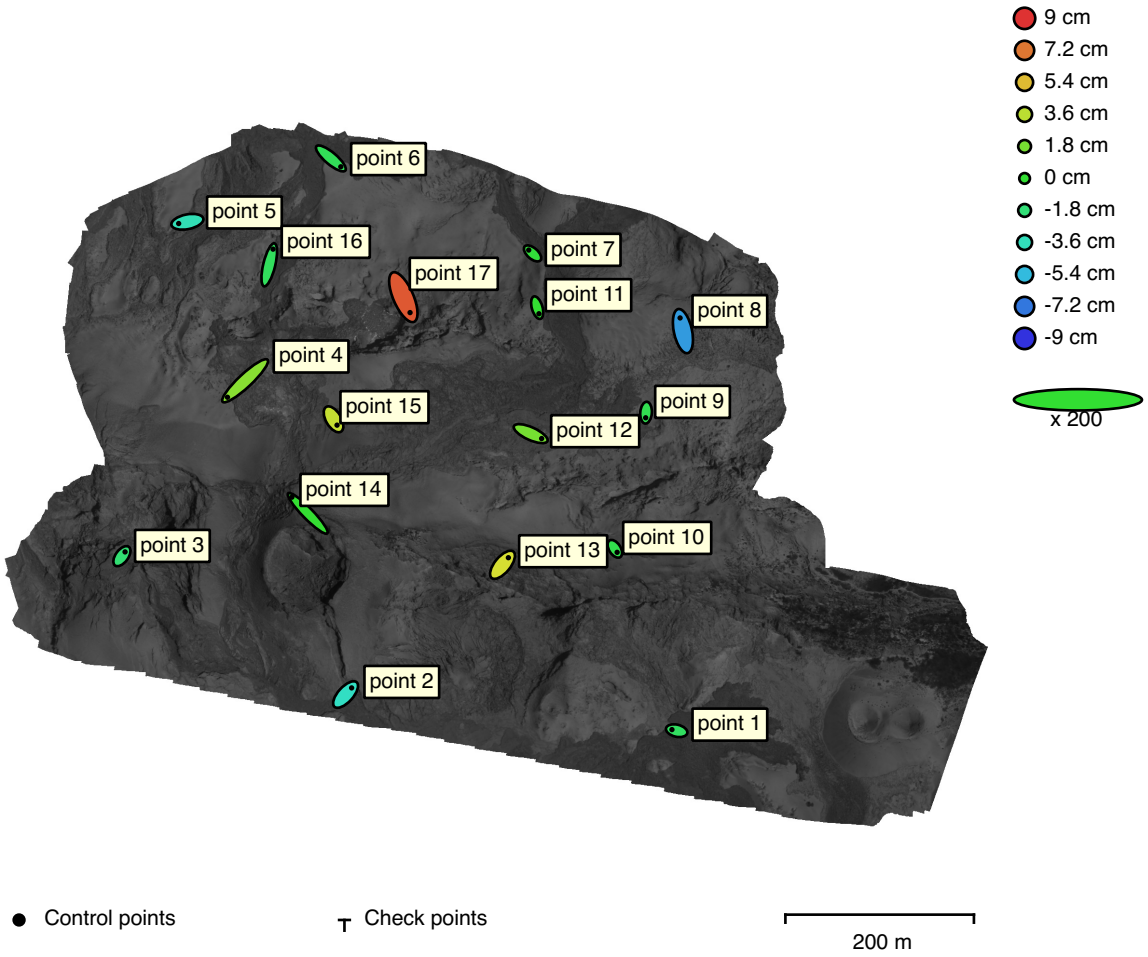



Fig. 3. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

| Count | X error (cm) | Y error (cm) | Z error (cm) | XY error (cm) | Total (cm) |
|---|---|---|---|---|---|
| 17 | 8.38584 | 10.0379 | 3.2407 | 13.0798 | 13.4753 |

Table 3. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

| Label | X error (cm) | Y error (cm) | Z error (cm) | Total (cm) | Image (pix) |
|---|---|---|---|---|---|
| point 1 | -5.01629 | 1.15995 | -1.21491 | 5.29005 | 0.571 (12) |
| point 2 | 6.39783 | 7.04637 | -3.78675 | 10.2432 | 1.295 (7) |
| point 3 | 3.34939 | 4.513 | -1.67701 | 5.86498 | 1.864 (3) |
| point 4 | -18.7167 | -17.4957 | 2.24012 | 25.7183 | 1.698 (10) |
| point 5 | -9.25146 | -1.83737 | -3.43526 | 10.0383 | 1.415 (9) |
| point 6 | 10.5129 | -8.87413 | -0.995593 | 13.7936 | 1.021 (11) |
| point 7 | -4.06049 | 3.55885 | -0.191591 | 5.40275 | 0.541 (9) |
| point 8 | -3.001 | 13.9702 | -6.27215 | 15.6049 | 1.657 (12) |
| point 9 | -0.400649 | -5.40946 | -0.793492 | 5.48201 | 0.446 (11) |
| point 10 | 2.42248 | -3.7146 | -0.705994 | 4.49055 | 0.370 (7) |
| point 11 | 1.89119 | -6.46152 | 0.00614753 | 6.7326 | 0.725 (7) |
| point 12 | 11.6188 | -5.21782 | 1.75754 | 12.8573 | 1.142 (8) |
| point 13 | 6.21917 | 7.52092 | 4.29705 | 10.6633 | 0.881 (9) |
| point 14 | -16.8042 | 17.1749 | 0.0466337 | 24.0283 | 1.638 (7) |
| point 15 | 3.69001 | -6.19846 | 3.83383 | 8.16916 | 1.604 (5) |
| point 16 | 4.02205 | 16.6167 | -1.11472 | 17.1328 | 0.641 (20) |
| point 17 | 7.12706 | -16.3518 | 8.00608 | 19.5518 | 1.171 (17) |
| Total | 8.38584 | 10.0379 | 3.2407 | 13.4753 | 1.125 |

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

# Digital Elevation Model

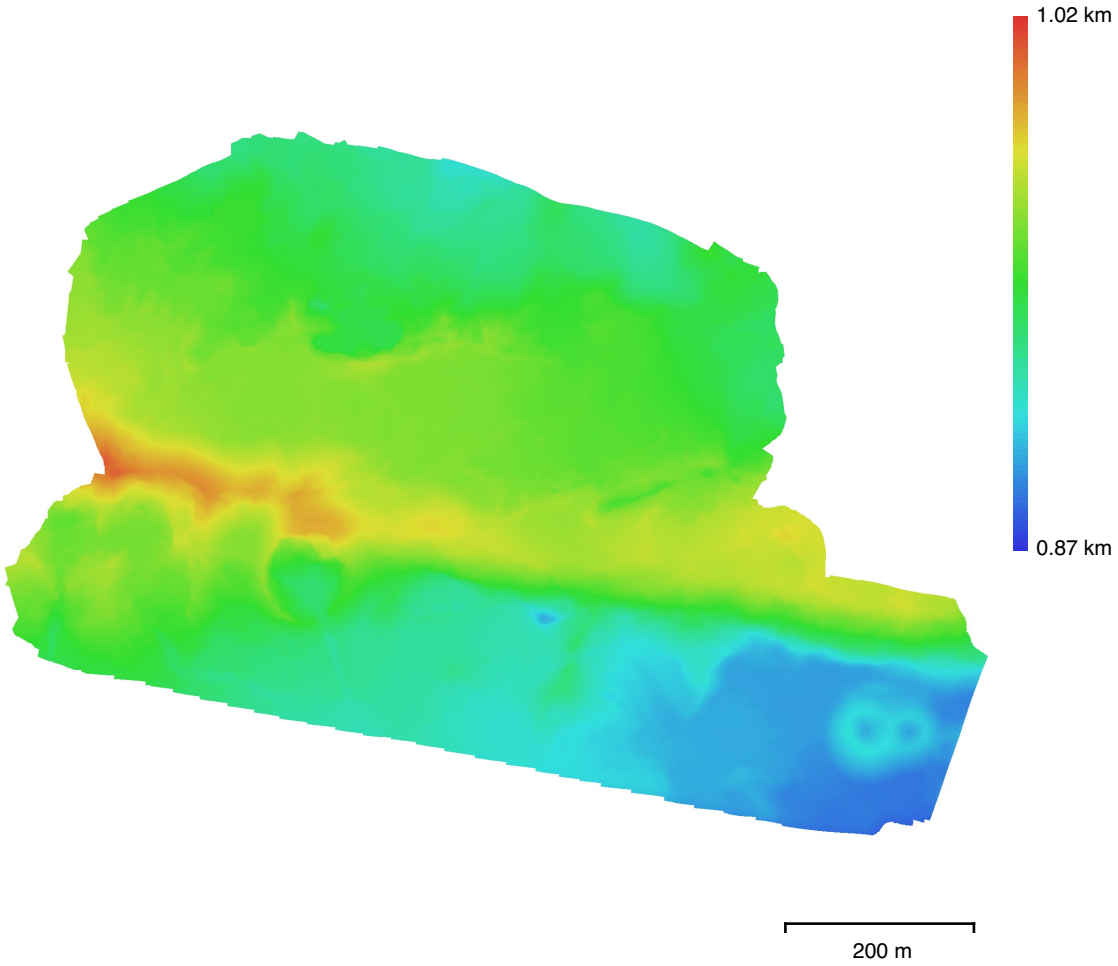



Fig. 4. Reconstructed digital elevation model.

| | |
|---|---|
| Resolution: | 35.8 cm/pix |
| Point density: | 7.81 points/m² |

# Processing Parameters

| | |
|---|---|
| General | |
| Cameras | 443 |
| Aligned cameras | 443 |
| Markers | 17 |
| Coordinate system | WGS 84 / UTM zone 15S (EPSG::32715) |
| Rotation angles | Yaw, Pitch, Roll |
| Point Cloud | |
| Points | 104,016 of 136,680 |
| RMS reprojection error | 0.12473 (0.388271 pix) |
| Max reprojection error | 0.36884 (4.17982 pix) |
| Mean key point size | 2.94578 pix |
| Point colors | 1 bands, uint16 |
| Key points | No |
| Average tie point multiplicity | 4.71821 |
| Alignment parameters | |
| Accuracy | High |
| Generic preselection | No |
| Key point limit | 0 |
| Tie point limit | 0 |
| Matching time | 10 minutes 13 seconds |
| Optimization parameters | |
| Parameters | f, b1, b2, k1-k3, p1, p2 |
| Adaptive camera model fitting | No |
| Optimization time | 5 seconds |
| Dense Point Cloud | |
| Points | 4,895,841 |
| Point colors | 1 bands, uint16 |
| Depth maps generation parameters | |
| Quality | High |
| Filtering mode | Aggressive |
| Processing time | 17 minutes 30 seconds |
| Dense cloud generation parameters | |
| Processing time | 21 seconds |
| Model | |
| Faces | 979,162 |
| Vertices | 490,848 |
| Vertex colors | 1 bands, uint16 |
| Texture | 8,192 x 8,192, 2 bands, uint16 |
| Depth maps generation parameters | |
| Quality | High |
| Filtering mode | Aggressive |
| Reconstruction parameters | |
| Surface type | Arbitrary |
| Source data | Dense cloud |
| Interpolation | Enabled |
| Processing time | 4 minutes 40 seconds |
| Texturing parameters | |
| Mapping mode | Orthophoto |
| Blending mode | Mosaic |
| Texture size | 8,192 |
| Enable hole filling | Yes |

| | |
|---|---|
| General | |
| Enable ghosting filter | No |
| UV mapping time | 4 seconds |
| Blending time | 36 seconds |
| Orthomosaic | |
| Size | 5,853 x 4,203 |
| Coordinate system | WGS 84 / UTM zone 15S (EPSG::32715) |
| Colors | 1 bands, uint16 |
| Reconstruction parameters | |
| Blending mode | Mosaic |
| Surface | Mesh |
| Enable hole filling | Yes |
| Processing time | 41 seconds |
| Software version | 1.6.1.10009 |
| 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 |