



Structure from Motion (SfM) survey – southern Banning strand of the San Andreas Fault and Landers earthquake scarp on the Emerson Fault

Principal Investigators: Kendra Johnson, Edwin Nissen, J Ramon Arrowsmith, Kate Scharer

Colorado School of Mines 1500 Illinois St Golden, CO 80401	e-mail: kejohnso@mines.edu Phone: 970-426-9125
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1. System Description and Specifications

This survey was performed with an 11 mm Nikon D5100 camera from a tethered helium balloon platform. Full details of the two surveys can be found in K. Johnson et al., “Rapid mapping of ultra-fine fault zone topography with Structure from Motion”, submitted to *Geosphere*, 2014.

2. Areas of Interest

The survey area consisted of two small regions along faults in southern California. Both datasets were produced in order to test the accuracy and feasibility of our Structure from Motion (SfM) system. (1) The Washington Street site is located ~20 km due east of Palm Springs and covers a short section of the southern Banning strand of the San Andreas Fault that cuts through an alluvial fan and has not ruptured historically. This site serves as a test site for paleoseismic studies. (2) The Galway Lake Road site is ~45 km north of Yucca Valley. This site covers a segment of the Emerson Fault ruptured by the 1992 M_w 7.3 Landers earthquake and tests the feasibility of SfM as part of the immediate scientific response following an earthquake.

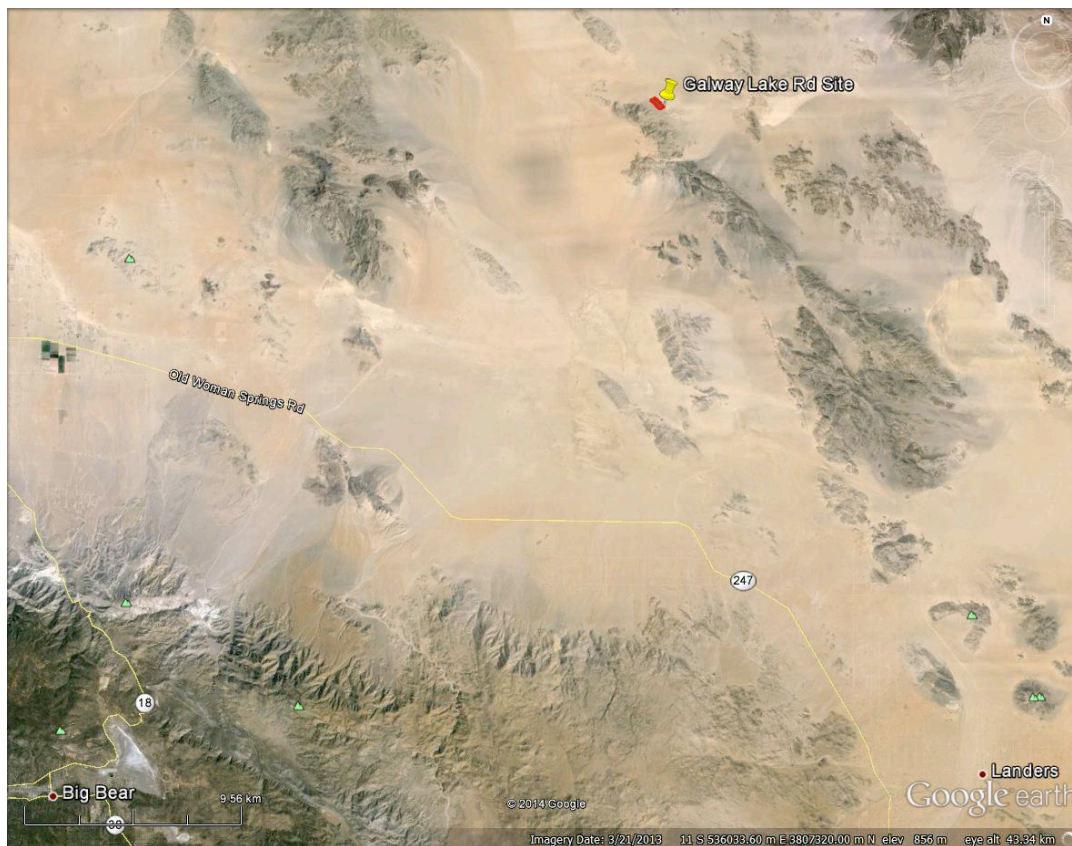
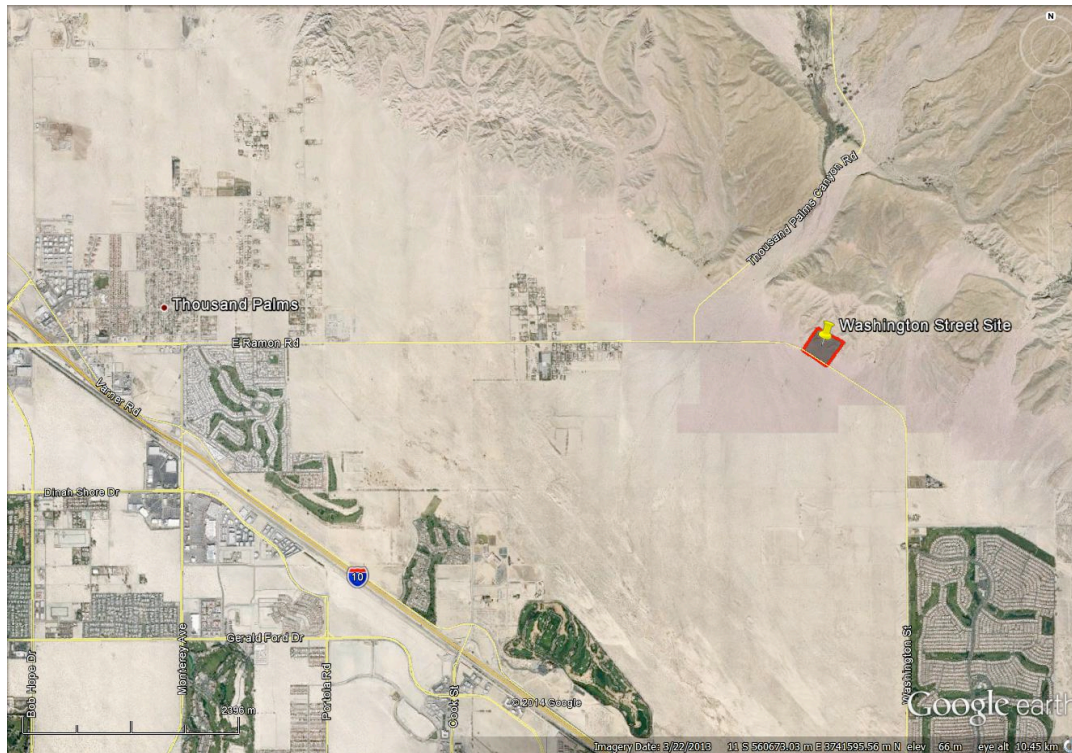


Figure 1 – Location of the Washington Street (top) and Galway Lake Road (bottom) sites (Google Earth).

3. Data Collection

a) **Survey Date:** The Washington Street photographs were collected on 02/02/2013, and the GCPs were collected independently by Kate Scharer on 01/03/2013. The Galway Lake Road photographs were collected on October 26, 2012.

b) Ground GPS

Nine ground control points were used for each site.

For the Washington Street site, a GeoXH was used to record GPS data along features such as ridgelines, bars, and swales. These data were overlain on a GoogleEarth image, which was easily correlated with the orthophoto produced using Structure from Motion. Nine features (rocks, bushes, stream/path intersections) identifiable in both images were used as ground control points.

For the Galway Lake Road site, GCPs were derived from TLS data collected independently in 2009 (see Haddad et al., 2012).

4. Data Deliverables

- a) **Horizontal Datum:** WGS 84/ UTM, Zone 11
- b) **Vertical Datum:** HAE (ellipsoid)
- c) **Projection:** WGS84/NUTM11
- d) **File Formats:** Along with the formats below, raw data (the photographs used in processing) are also available.

Washington Street site:

- 1. 3 cm DEM in TIFF format
- 2. point cloud (90% >700 points/m² with 50% >60 points/m²) in LAS format

Galway Lake Road site:

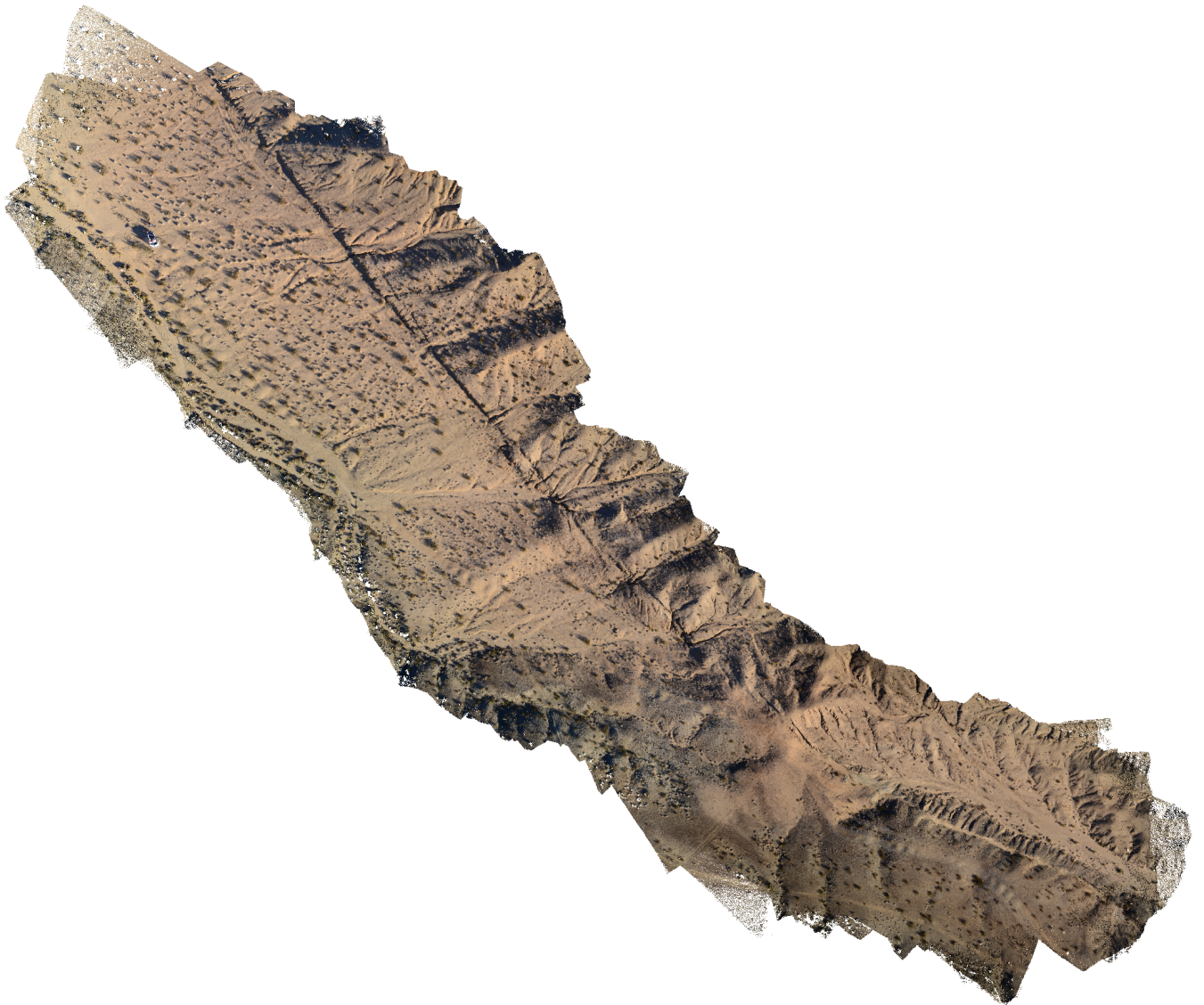
- 1. 2 cm DEM in TIFF format
- 2. point cloud (90% >530 points/m² with 50% >65 points/m² in LAS format

5. Processing Report

Agisoft PhotoScan

Processing Report

29 January 2014



Survey Data

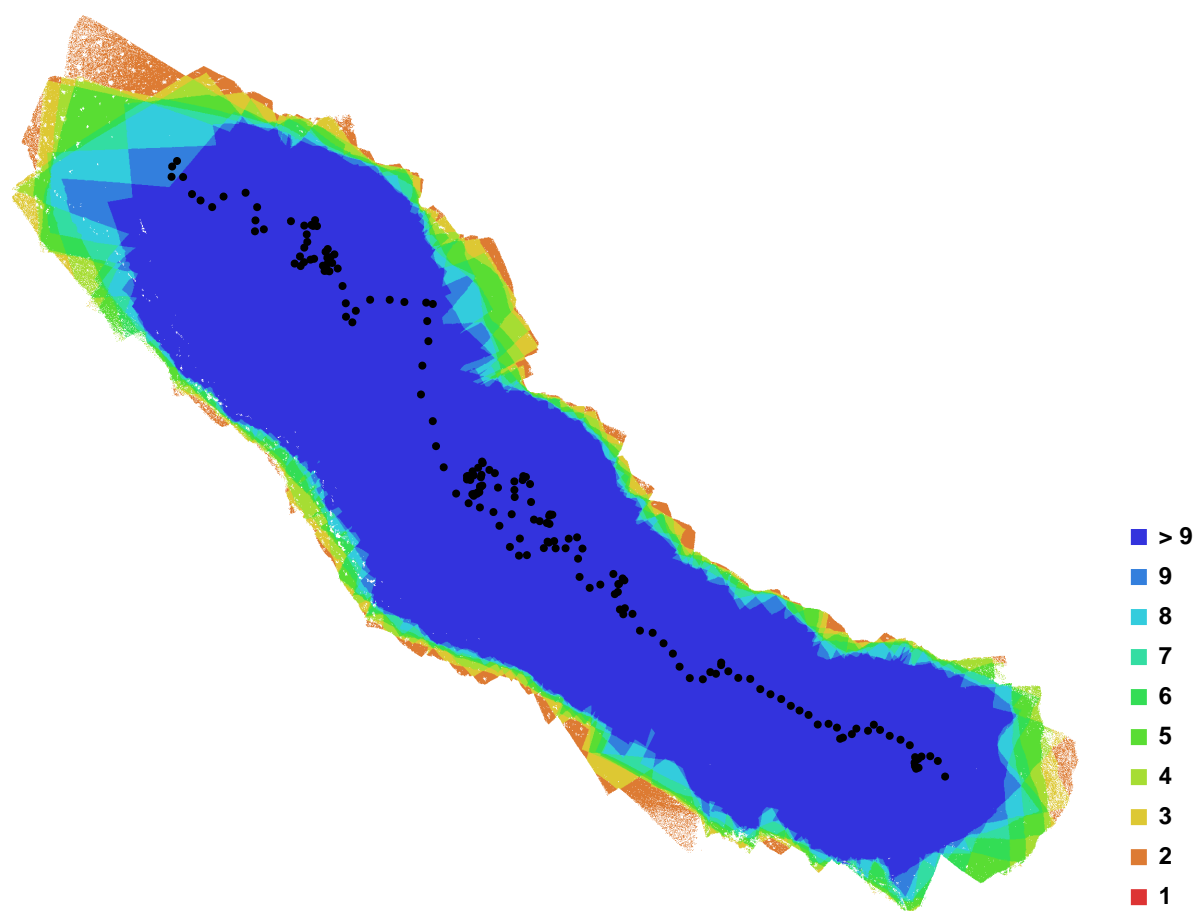


Fig. 1. Camera locations and image overlap.

Number of images:	450	Camera stations:	174
Flying altitude:	54.27 m	Tie-points:	1059281
Ground resolution:	0.021116 m/pix	Projections:	5646443
Coverage area:	0.0563448 sq km	Error:	0.525396 pix

Camera Model	Resolution	Focal Length	Precalibrated
NIKON D5100	4928 x 3264	11.5 mm	EXIF

Table. 1. Cameras.

Ground Control Points

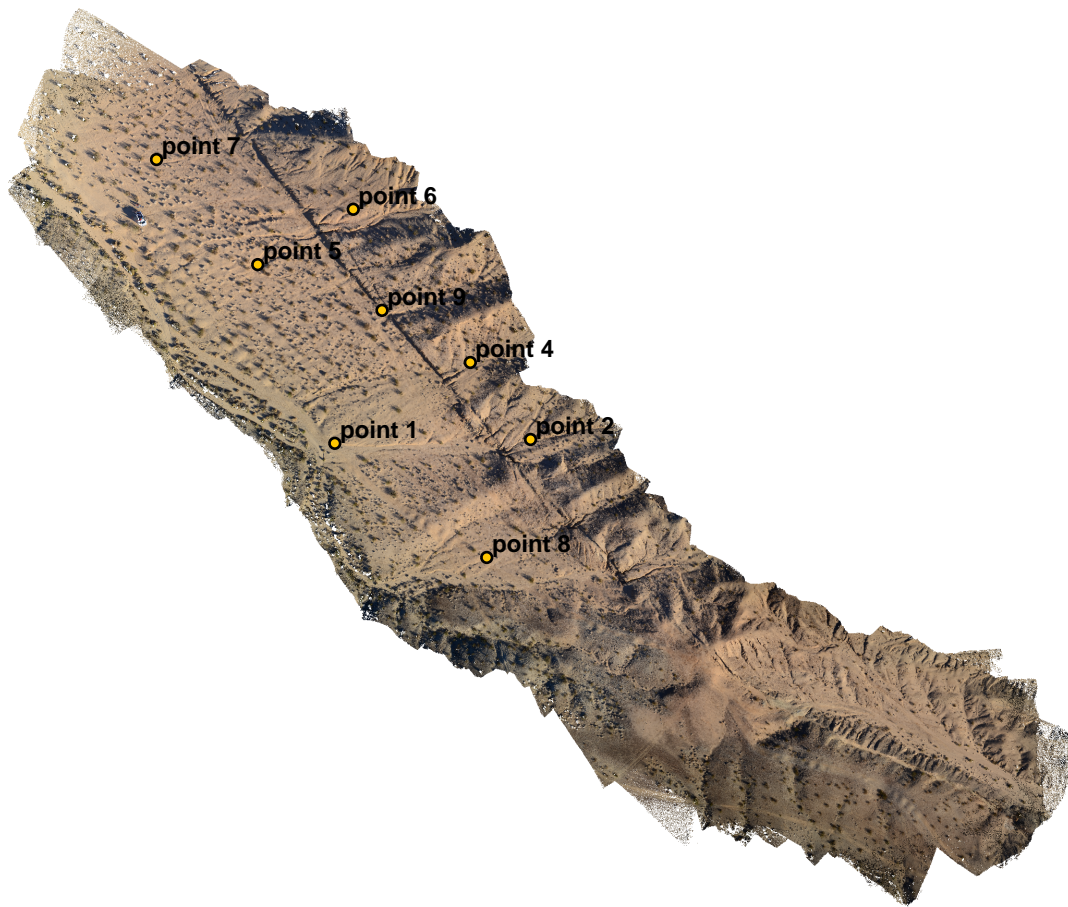


Fig. 2. GCP locations.

Label	X error (m)	Y error (m)	Z error (m)	Error (m)	Projections	Error (pix)
point 1	0.945261	-0.688552	0.055499	1.170770	13	0.204553
point 2	-0.889236	-1.610085	-0.114287	1.842871	42	0.101185
point 4	1.309244	-0.133925	0.069114	1.317889	9	0.108523
point 5	0.959638	1.437947	0.237876	1.745045	37	0.063781
point 6	-4.473788	-1.703310	-0.488513	4.811932	30	0.088490
point 7	2.063612	0.970136	0.343788	2.306046	9	0.053237
point 8	1.607477	-0.062365	0.236072	1.625916	53	0.101753
point 9	-1.522226	1.790172	-0.339535	2.374273	29	0.087683

Table. 2. Control points.

Digital Elevation Model

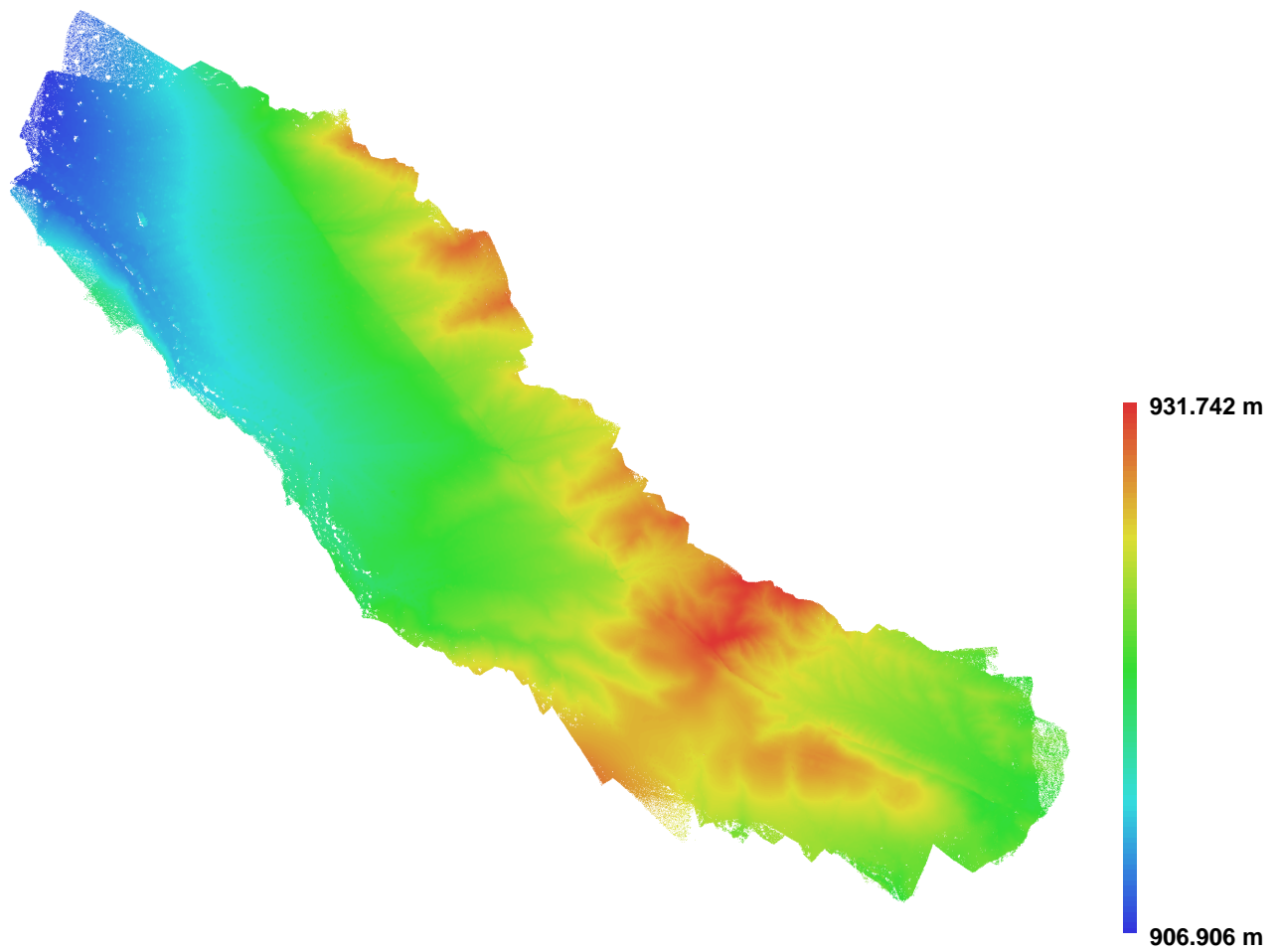


Fig. 3. Reconstructed digital elevation model.

Resolution: 0.018537 m/pix
Point density: 377.694 points per sq m