



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

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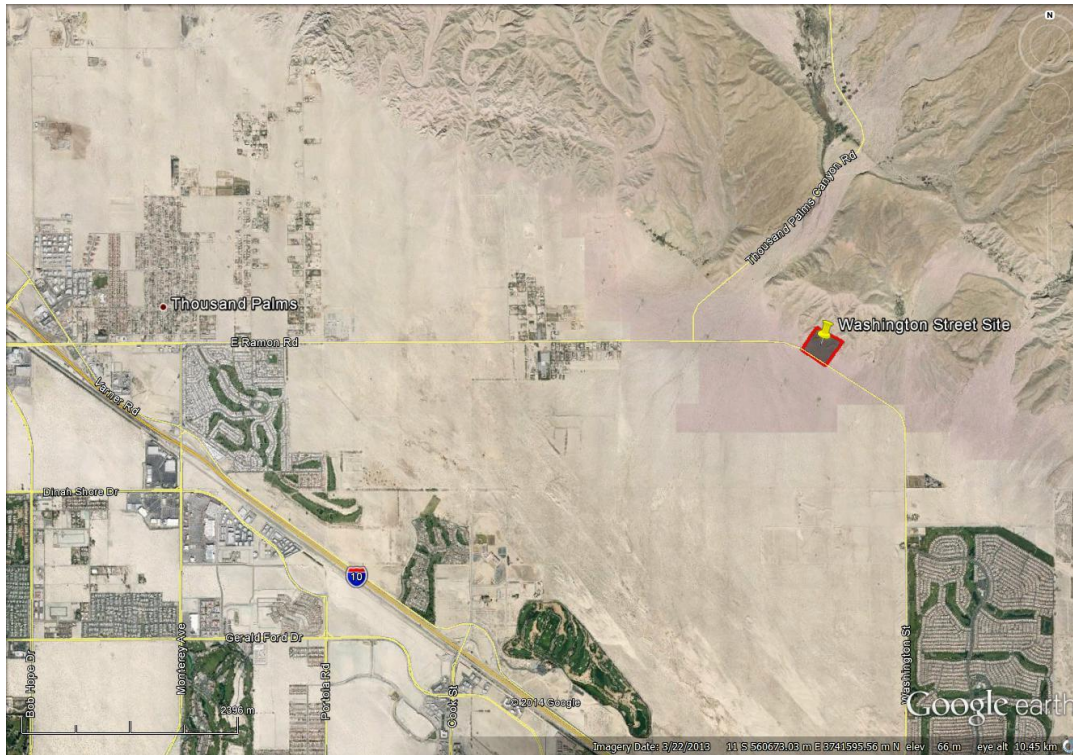
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### **1. System Description and Specifications**

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/m<sup>2</sup> with 50% >60 points/m<sup>2</sup>) in LAS format

Galway Lake Road site:

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

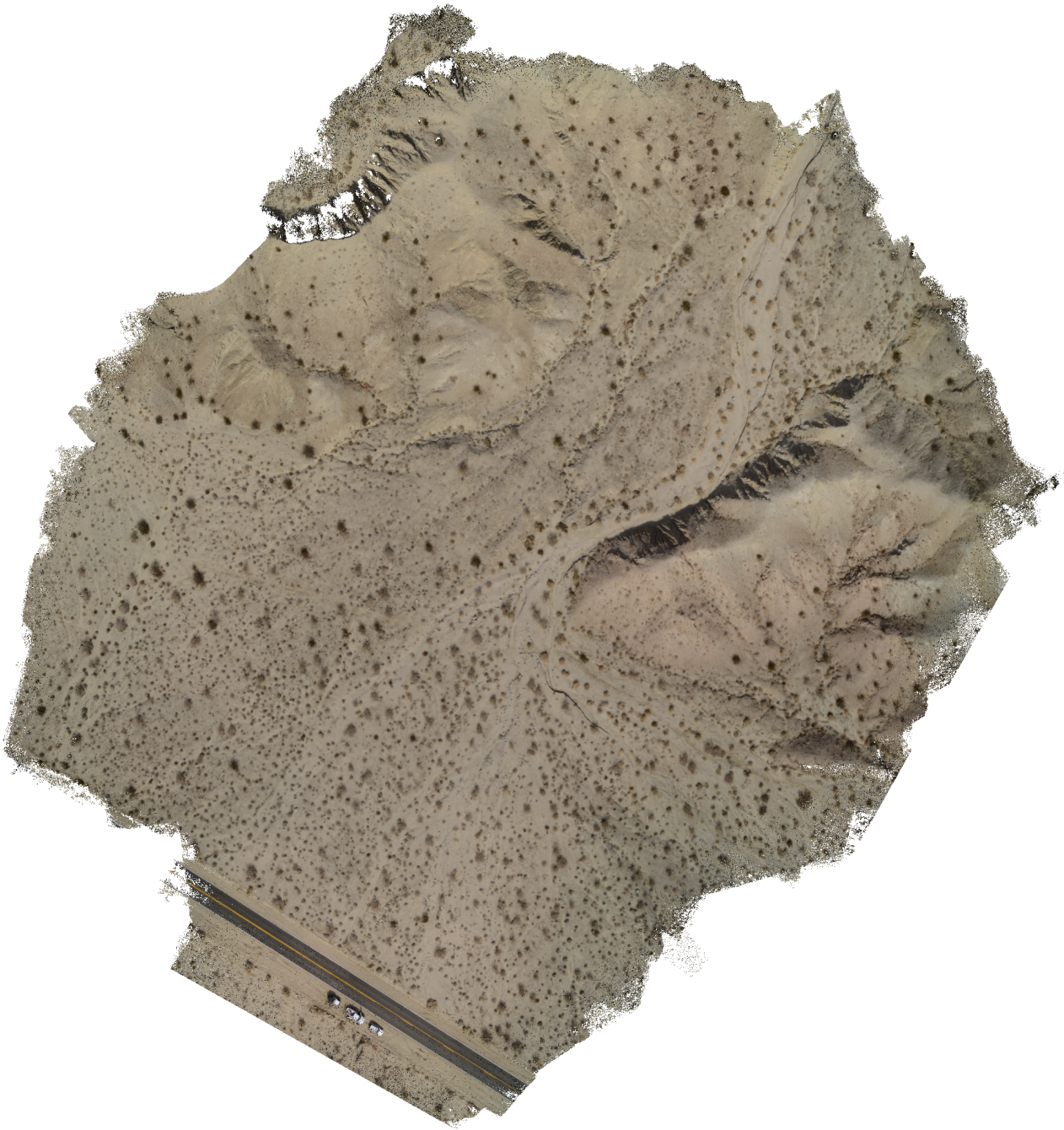
### 5. Processing Report



# Agisoft PhotoScan

Processing Report

26 March 2014



# Survey Data

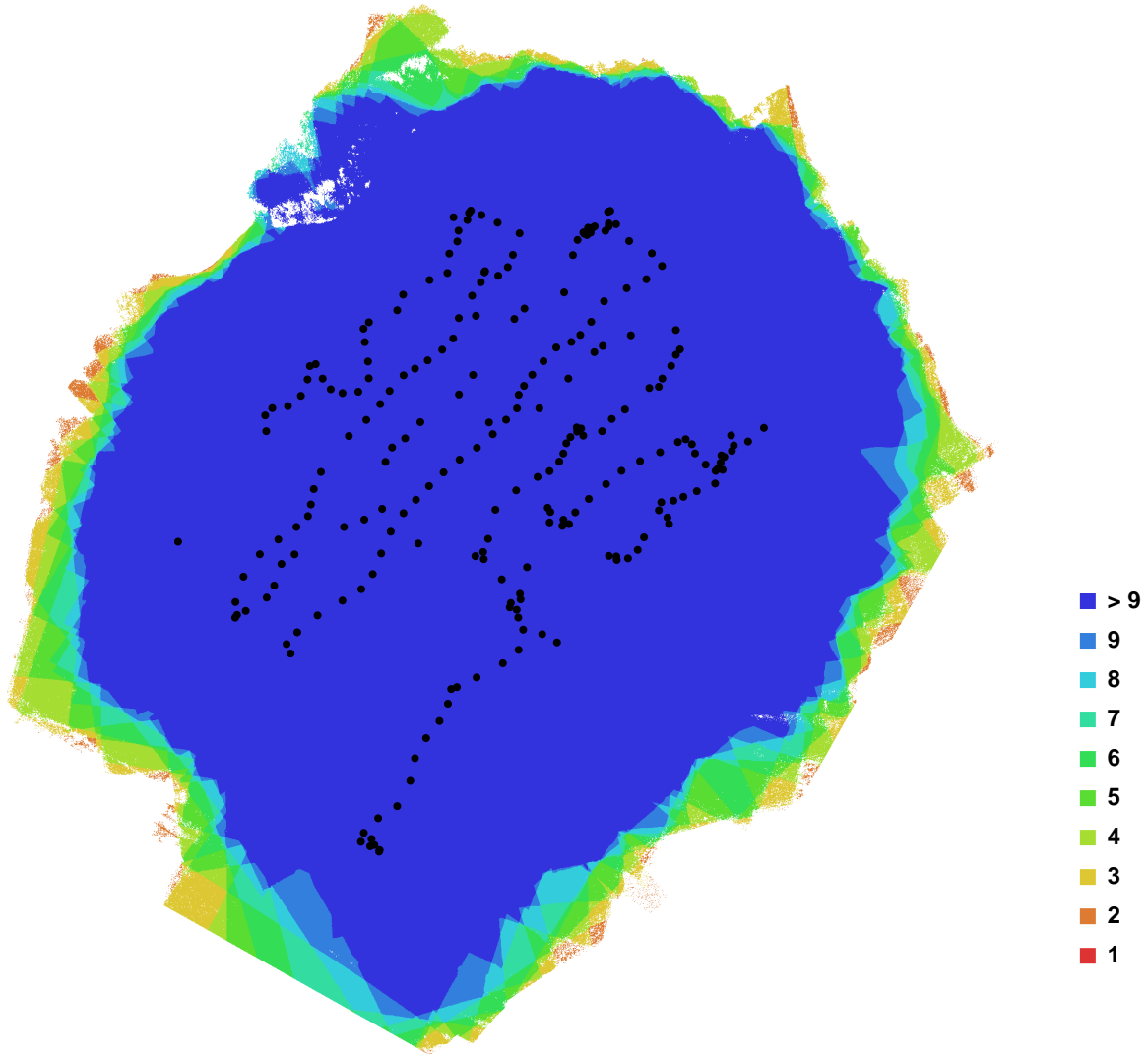


Fig. 1. Camera locations and image overlap.

Number of images:	233	Camera stations:	233
Flying altitude:	73.8689 m	Tie-points:	262799
Ground resolution:	0.0259524 m/pix	Projections:	1378568
Coverage area:	0.066803 sq km	Error:	0.810445 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
NIKON D5100 (11 mm)	4928 x 3264	11 mm	5.03235 x 5.03235 um	No

Table. 1. Cameras.

# Ground Control Points

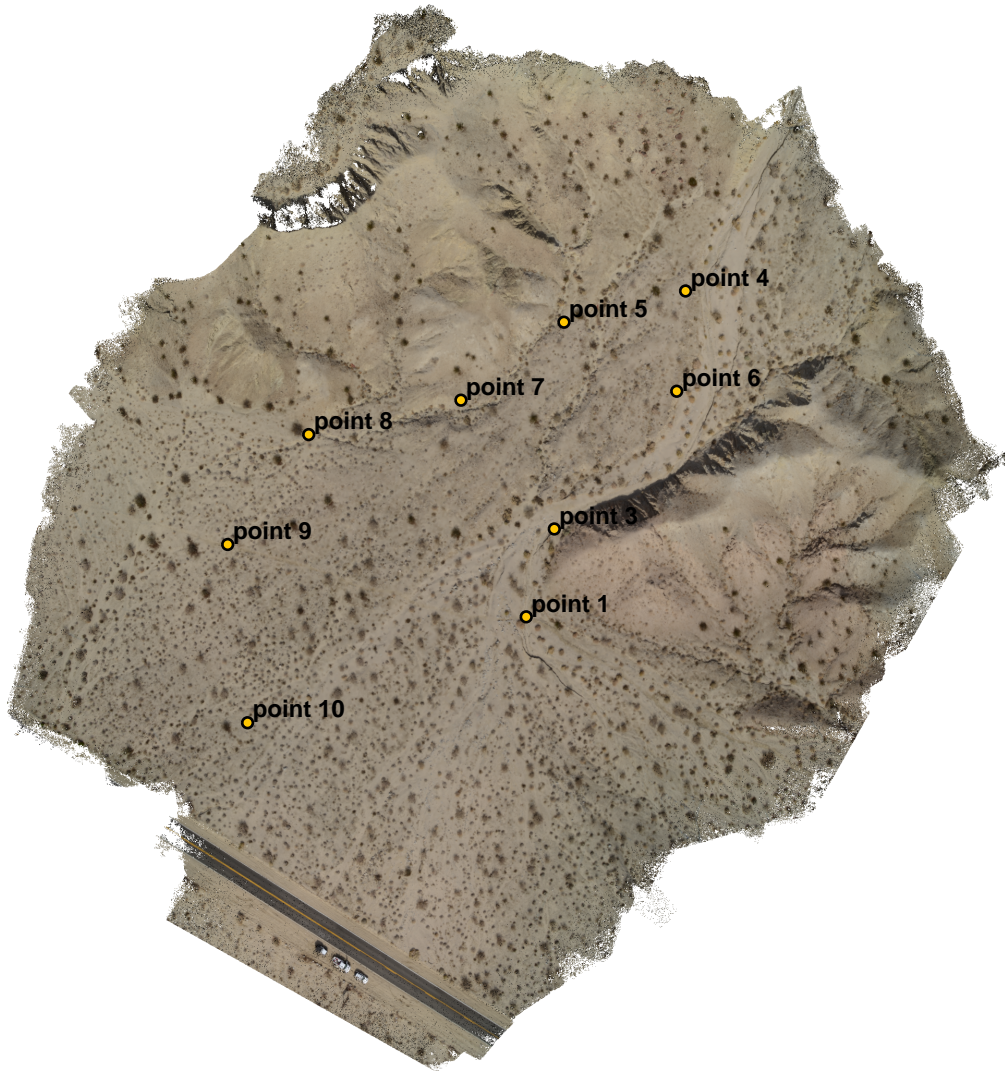


Fig. 2. GCP locations.

Label	X error (m)	Y error (m)	Z error (m)	Error (m)	Projections	Error (pix)
point 1	0.159973	-0.010875	0.123769	0.202555	73	0.125321
point 10	0.382618	0.250826	-0.036319	0.458944	28	0.135816
point 3	0.111922	-0.014608	0.060474	0.128051	111	0.137338
point 4	-0.067654	-0.200048	0.070815	0.222735	66	0.136351
point 5	0.191332	-0.137696	6.406889	6.411224	107	0.139194
point 6	0.118935	-0.136836	-0.124533	0.219950	89	0.129639
point 7	0.374254	0.016446	-0.181649	0.416332	115	0.132005
point 8	-1.134795	0.056395	0.139483	1.144725	63	0.139971
point 9	0.054748	0.038708	-0.052034	0.084872	48	0.119252
<b>Total</b>	<b>0.430848</b>	<b>0.127322</b>	<b>2.138125</b>	<b>2.184816</b>	<b>700</b>	<b>0.133488</b>

Table. 2. Control points.



# Digital Elevation Model

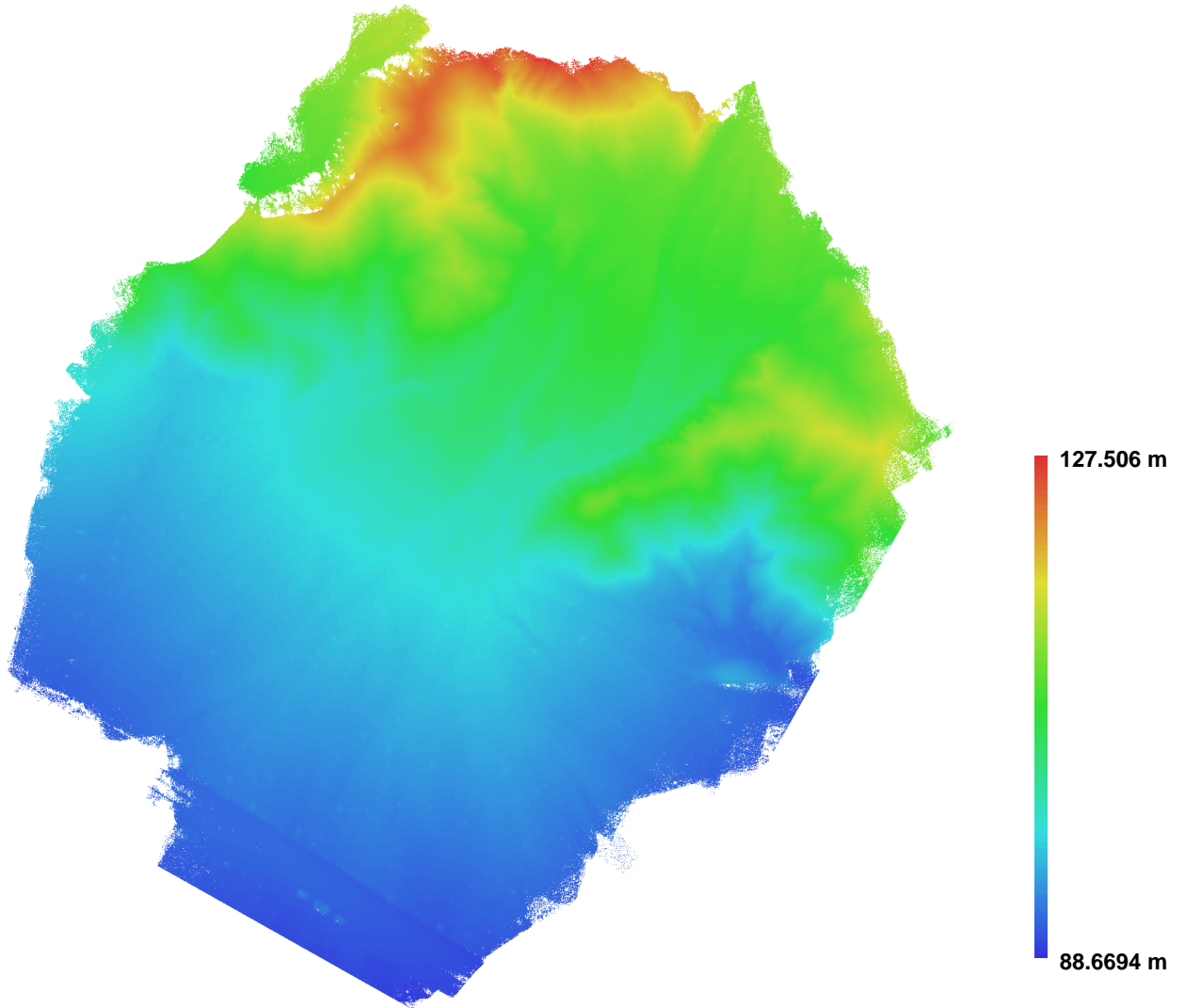


Fig. 3. Reconstructed digital elevation model.

Resolution: 0.0259524 m/pix  
Point density: 1438.89 points per sq m