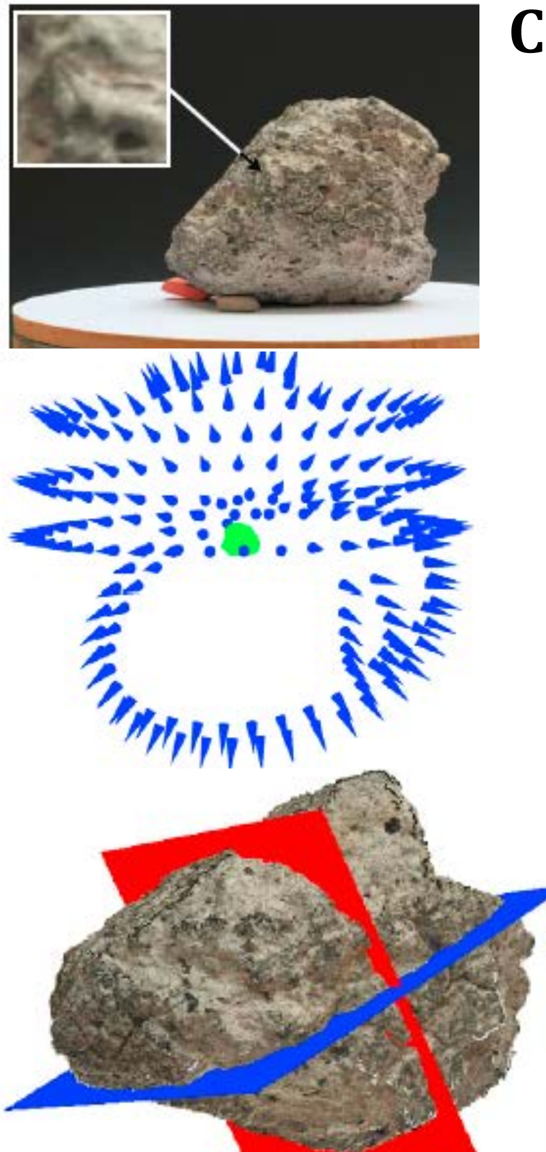
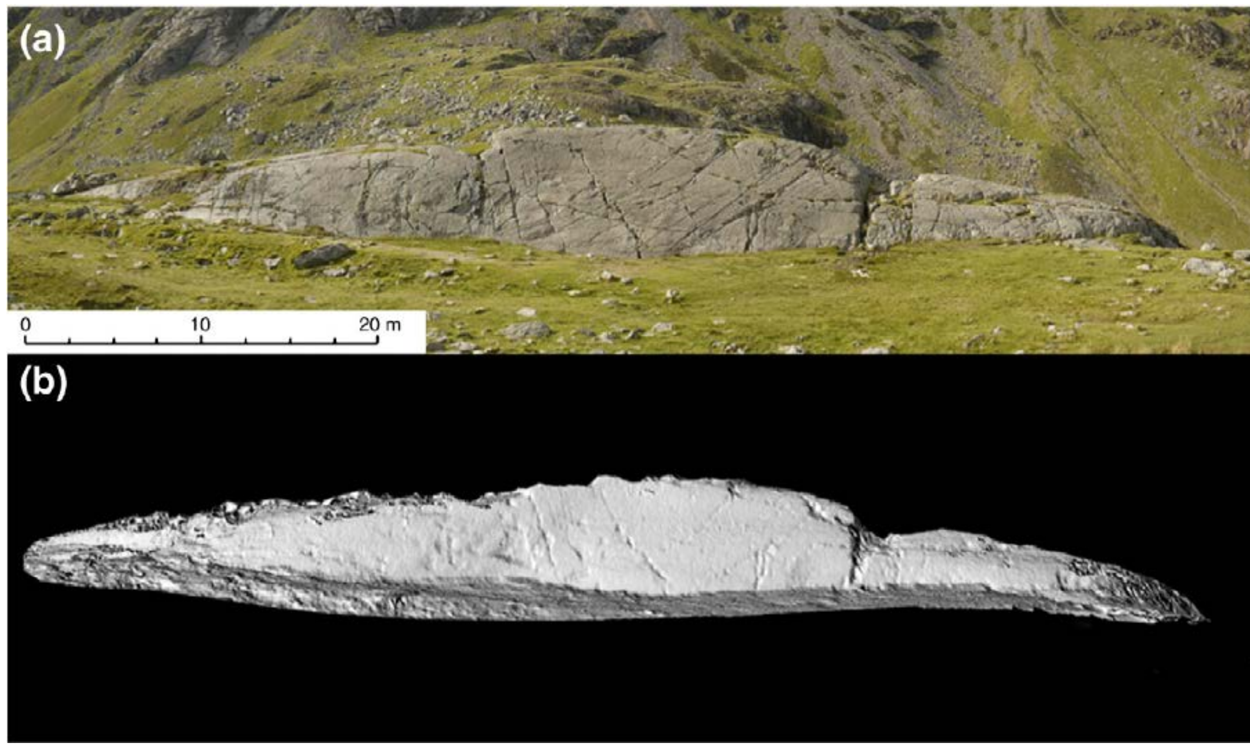
Applications of SfM

Characterizing hand samples or outcrops

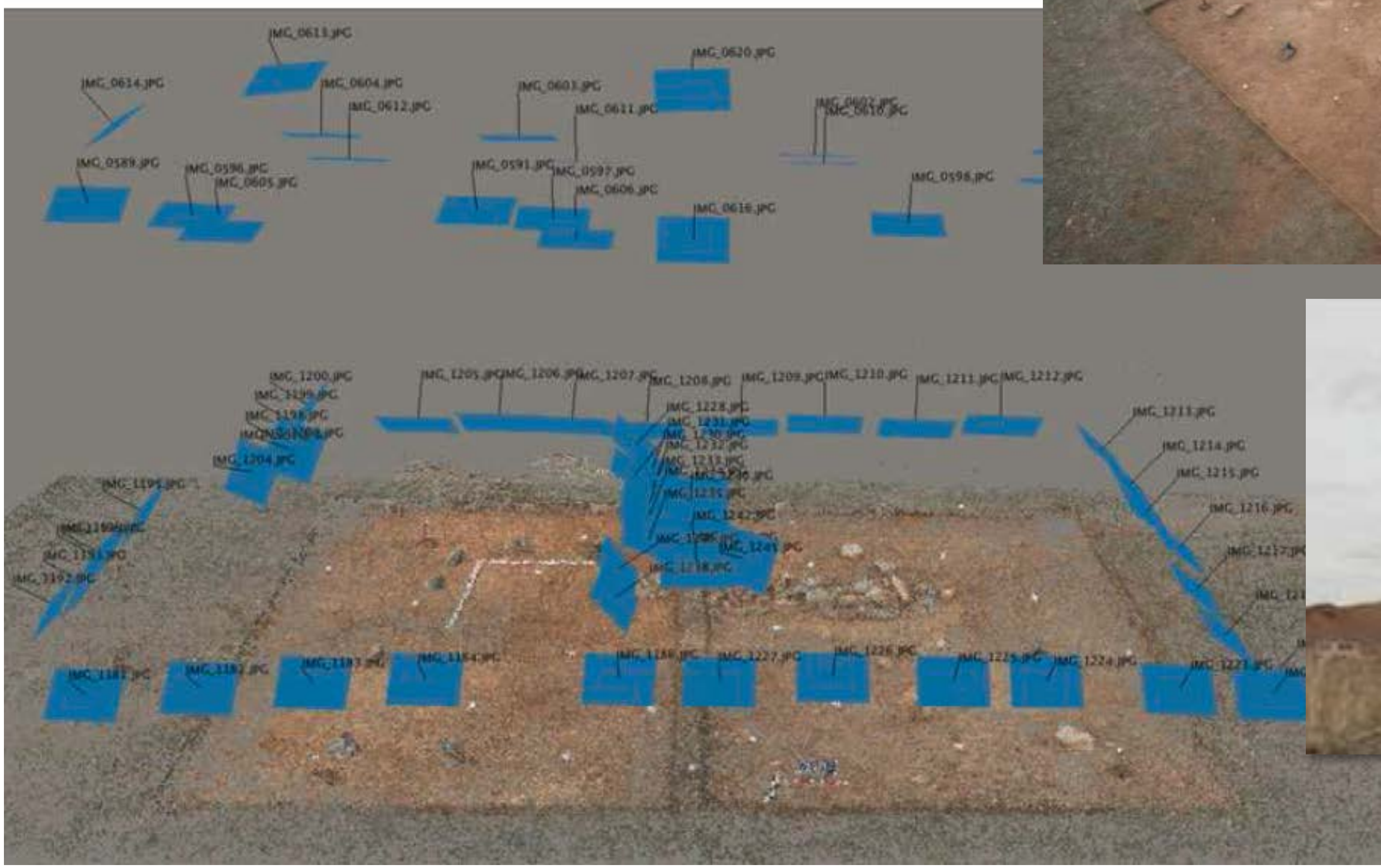




Left. James & Robson (2012). Straightforward reconstruction of 3D surfaces and topography with a camera: Accuracy and geoscience application. *Journal of Geophysical Research*

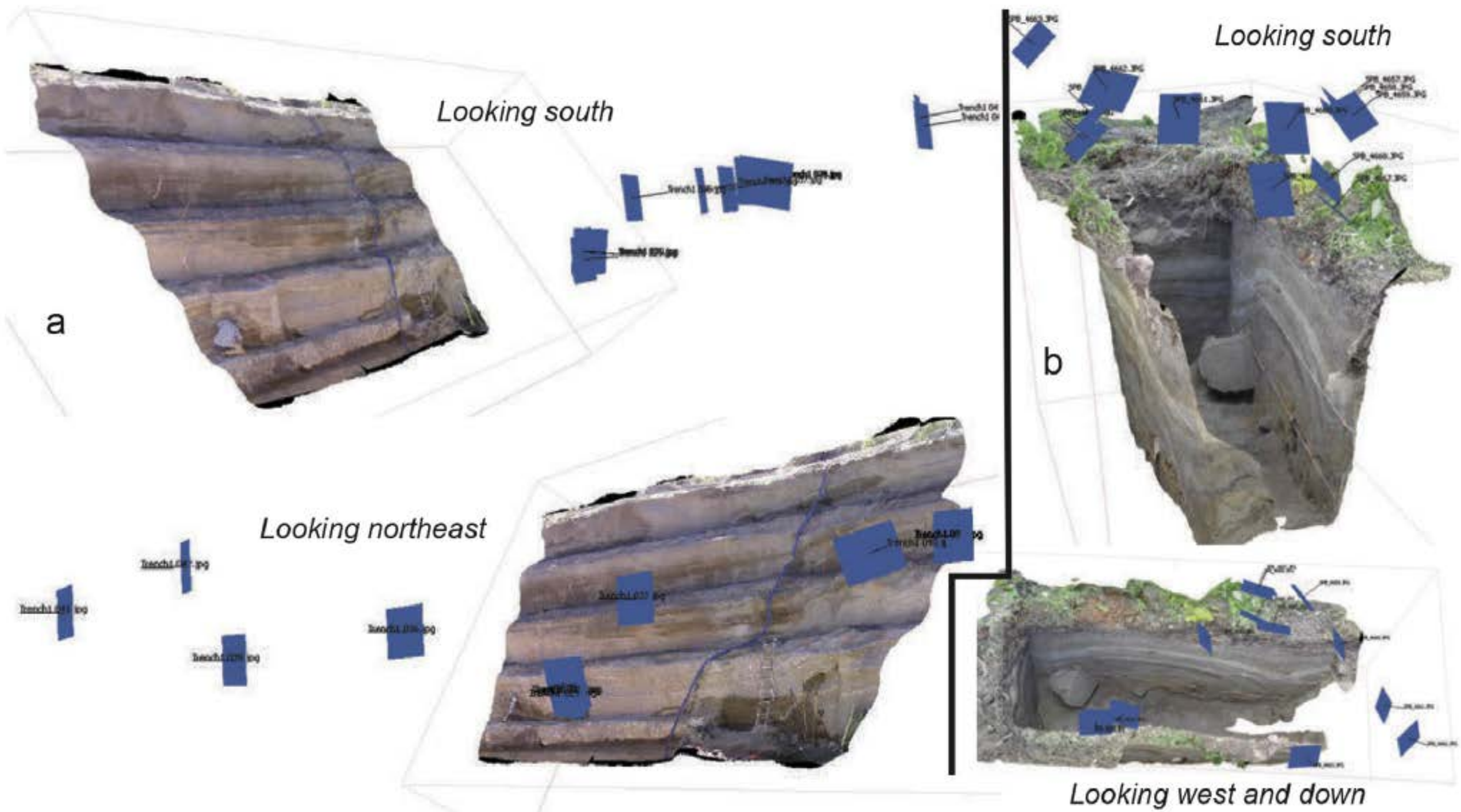
Right. Westoby *et al.* (2012). Structure-from-Motion' photogrammetry: A low-cost, effective tool for geoscience applications. *Geomorphology*

Archaeological mapping



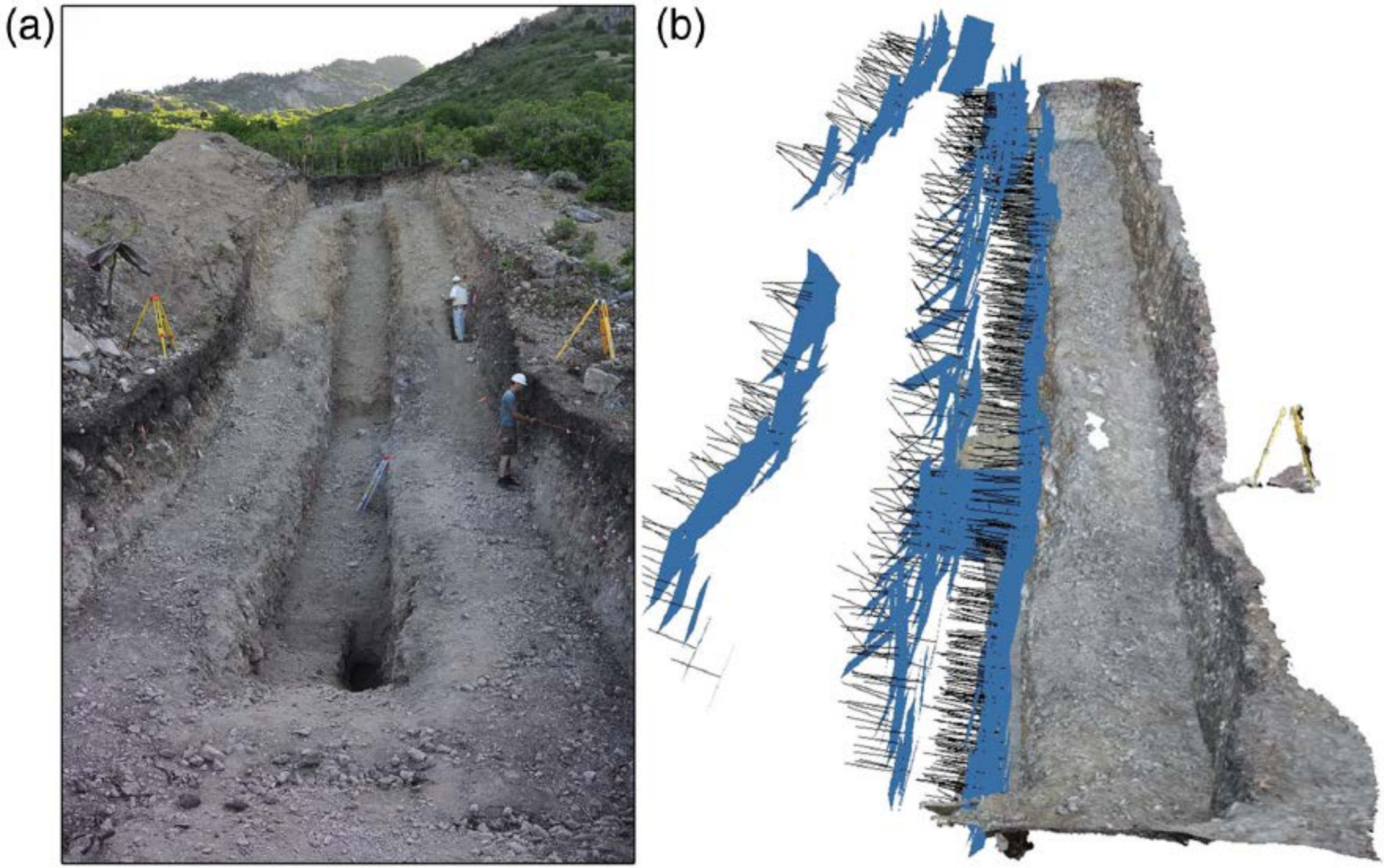
Plets *et al.* (2012). Three-dimensional recording of archaeological remains in the Altai mountains, *Cambridge Univ. Press*

Paleoseismic trenching



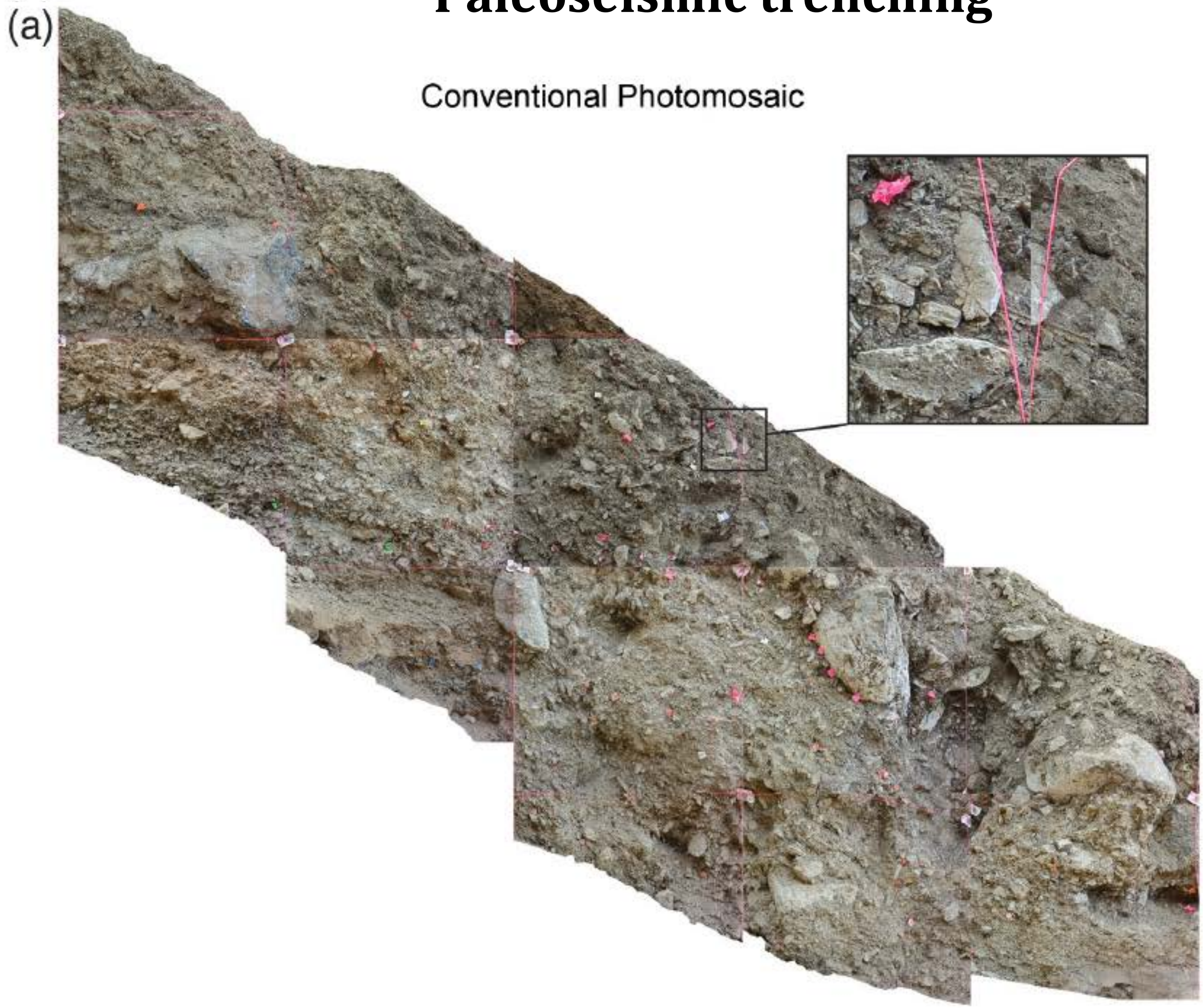
Bemis *et al.* (2014). Ground-based and UAV-Based photogrammetry: A multi-scale, high resolution mapping tool for structural geology and paleoseismology. *Journal of Structural Geology*

Paleoseismic trenching



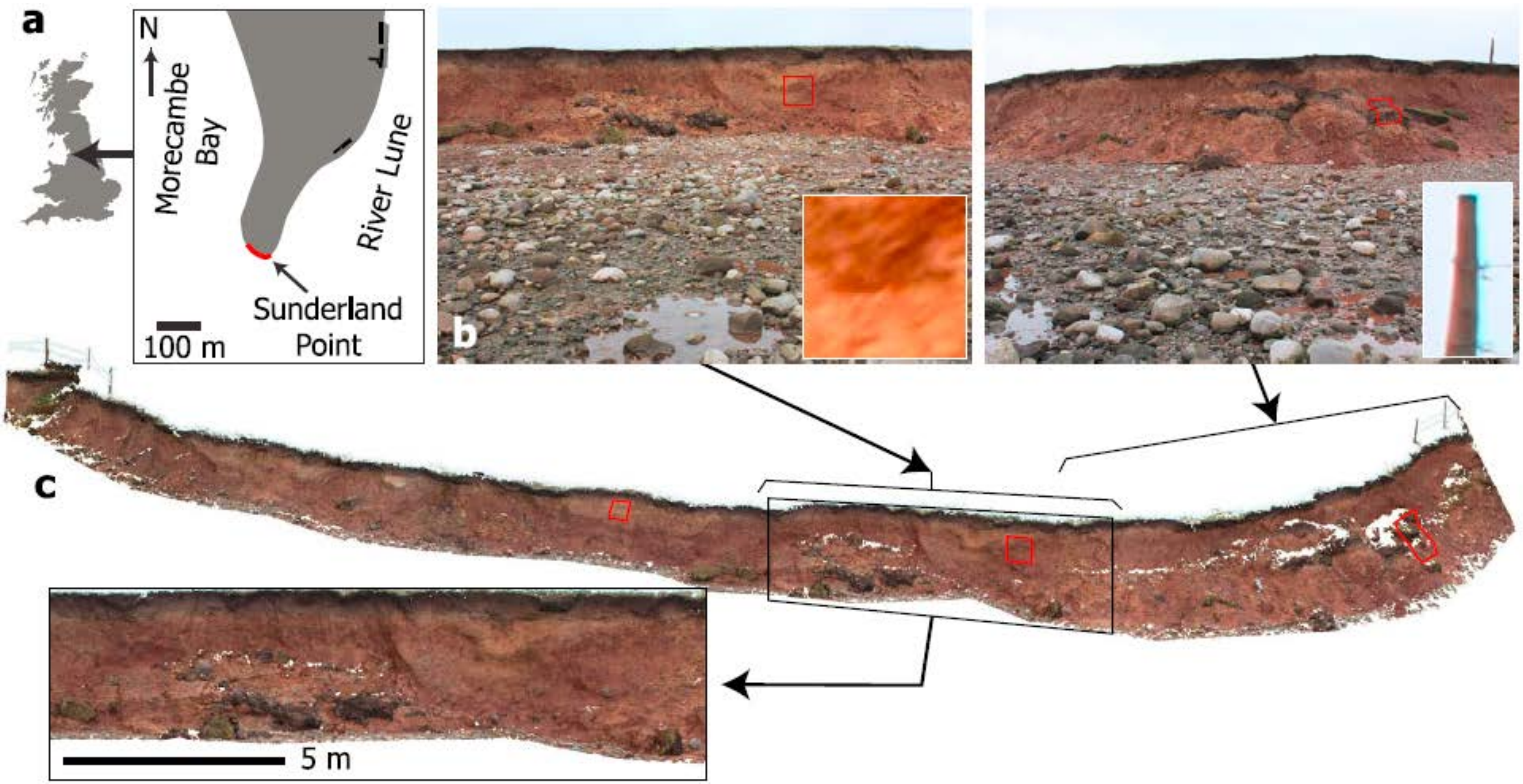
Reitman *et al.* (2015), High-Resolution Trench Photomosaics from Image-Based Modeling: Workflow and Error Analysis, *Bulletin of the Seismological Society of America*

Paleoseismic trenching



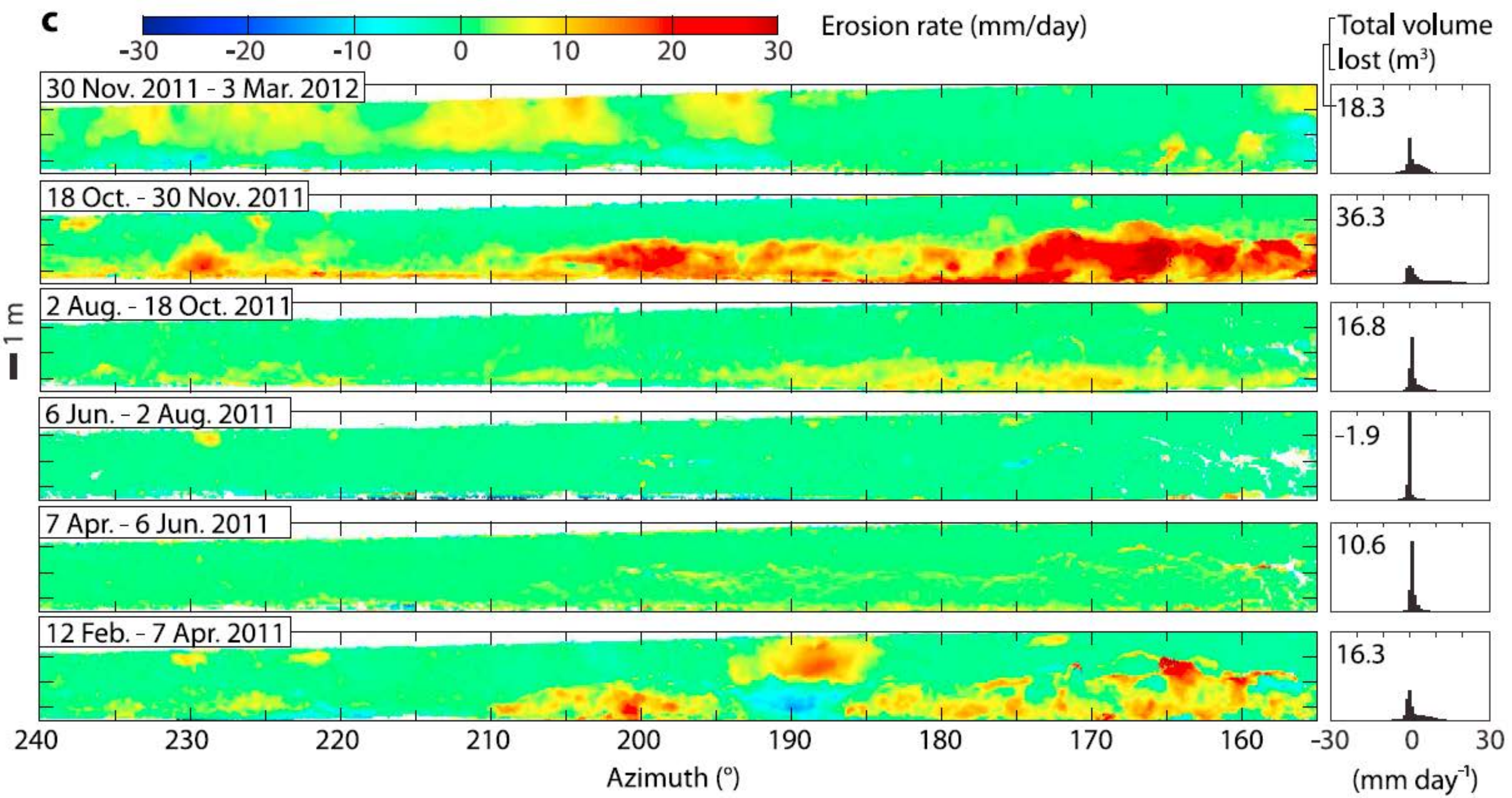
Reitman *et al.* (2015), High-Resolution Trench Photomosaics from Image-Based Modeling: Workflow and Error Analysis, *Bulletin of the Seismological Society of America*

Coastal erosion



James & Robson (2012). Straightforward reconstruction of 3D surfaces and topography with a camera: Accuracy and geoscience application. *Journal of Geophysical Research*

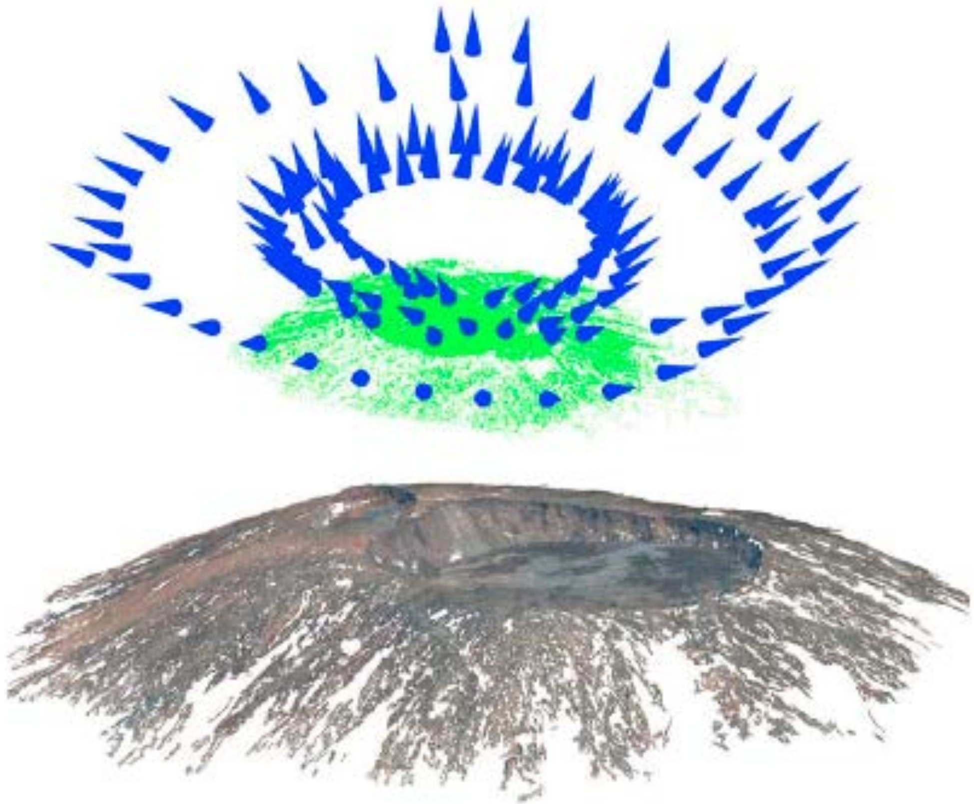
Coastal erosion

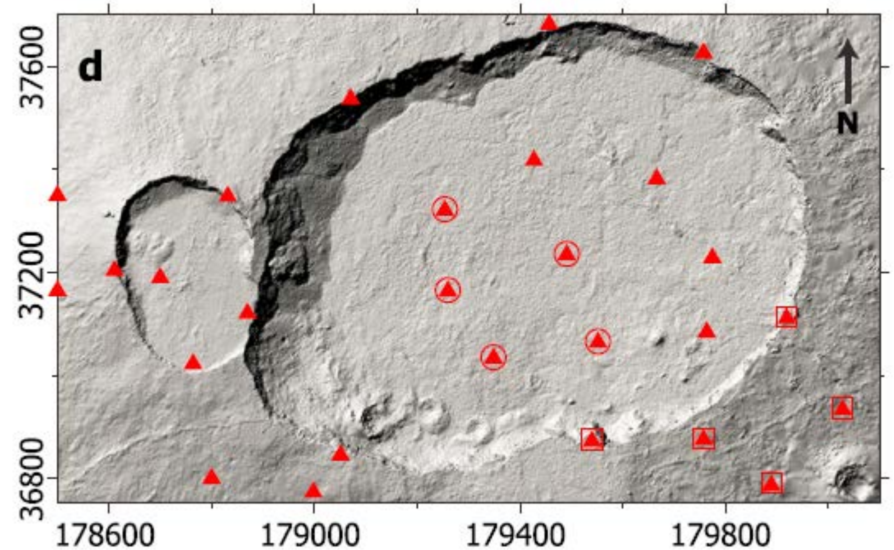


James & Robson (2012). Straightforward reconstruction of 3D surfaces and topography with a camera: Accuracy and geoscience application. *Journal of Geophysical Research*

Volcanic mapping

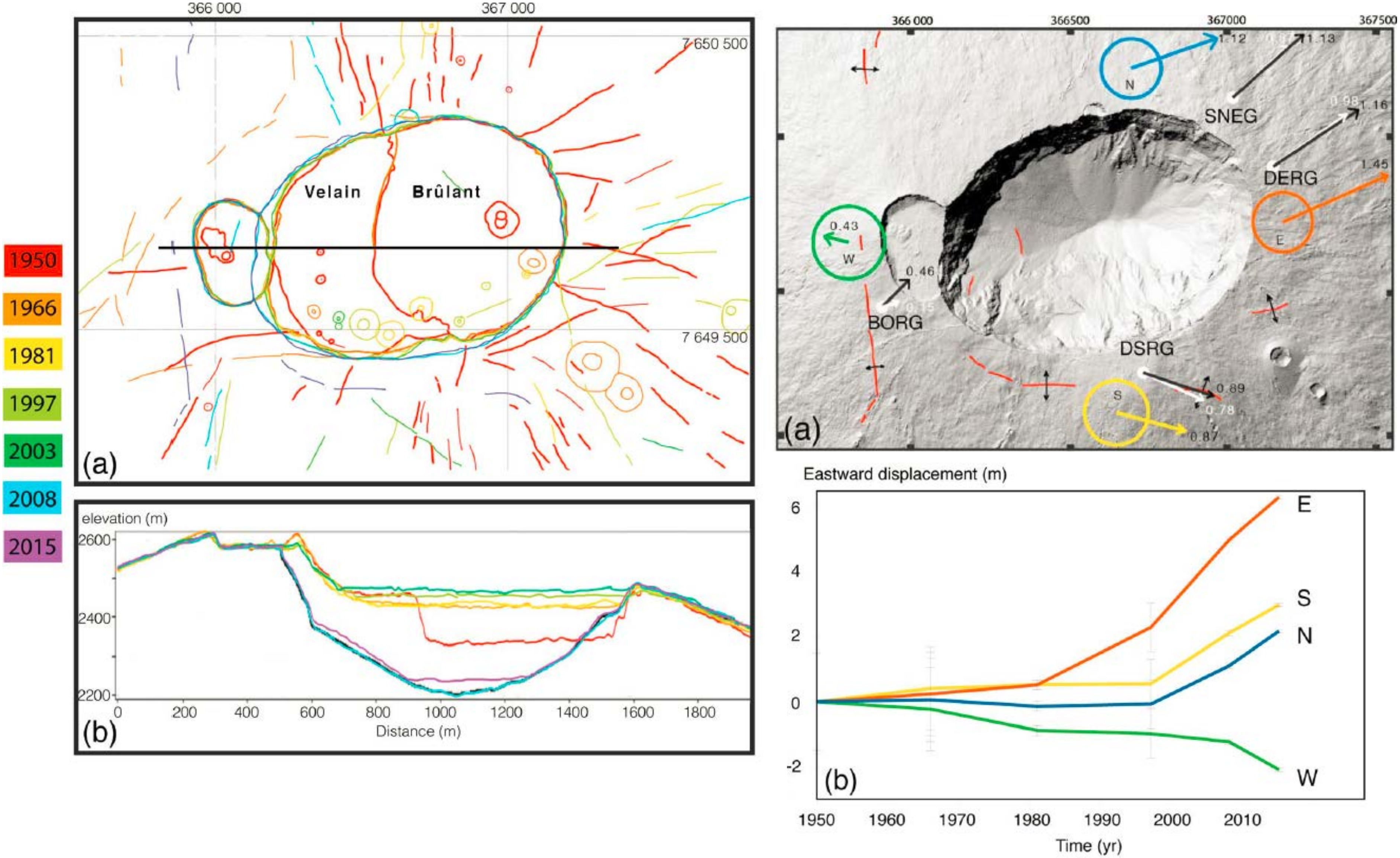
Summit crater, Piton de la Fournaise, La Réunion Island
~2 pts/m^2 point cloud using ~100 photos from a micro-light





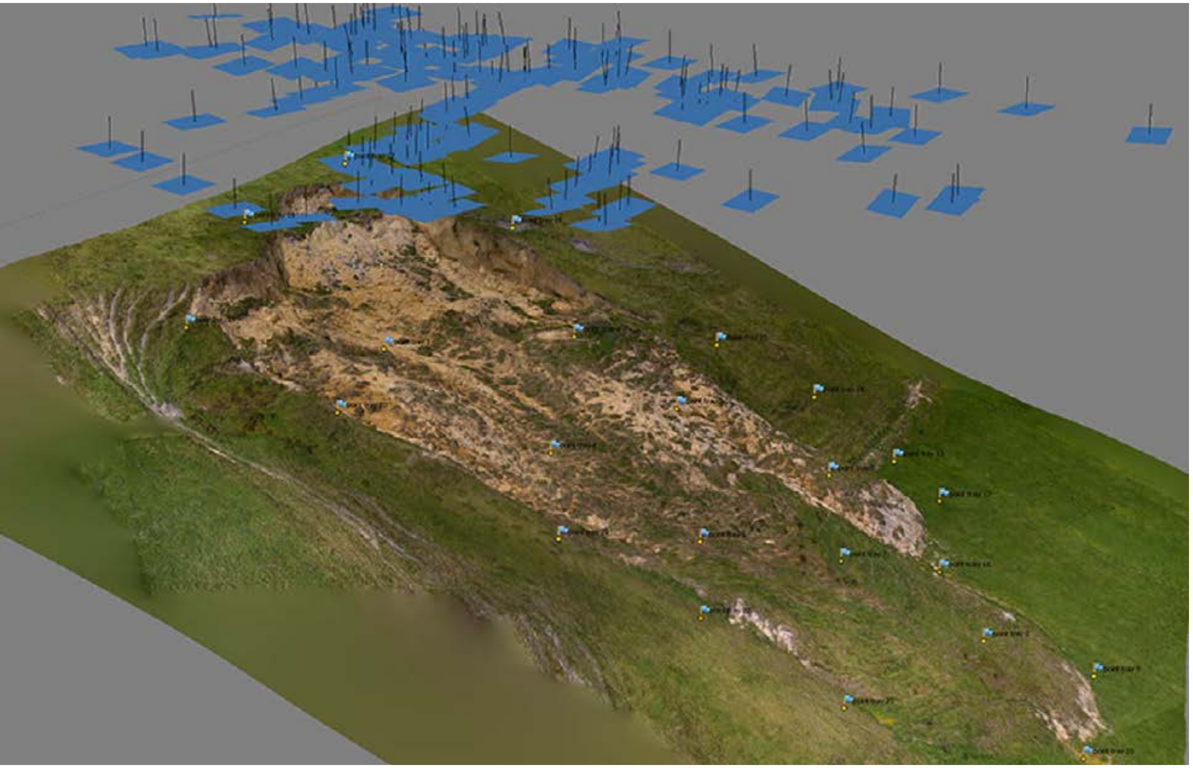
James & Robson (2012). Straightforward reconstruction of 3D surfaces and topography with a camera: Accuracy and geoscience application. *Journal of Geophysical Research*

Volcanic mapping



Derrien *et al.* (2015). Retrieving 65 years of volcano summit deformation from multitemporal structure from motion: The case of Piton de la Fournaise (La Réunion Island). *Geophys. Res. Lett.*

Landslide mapping



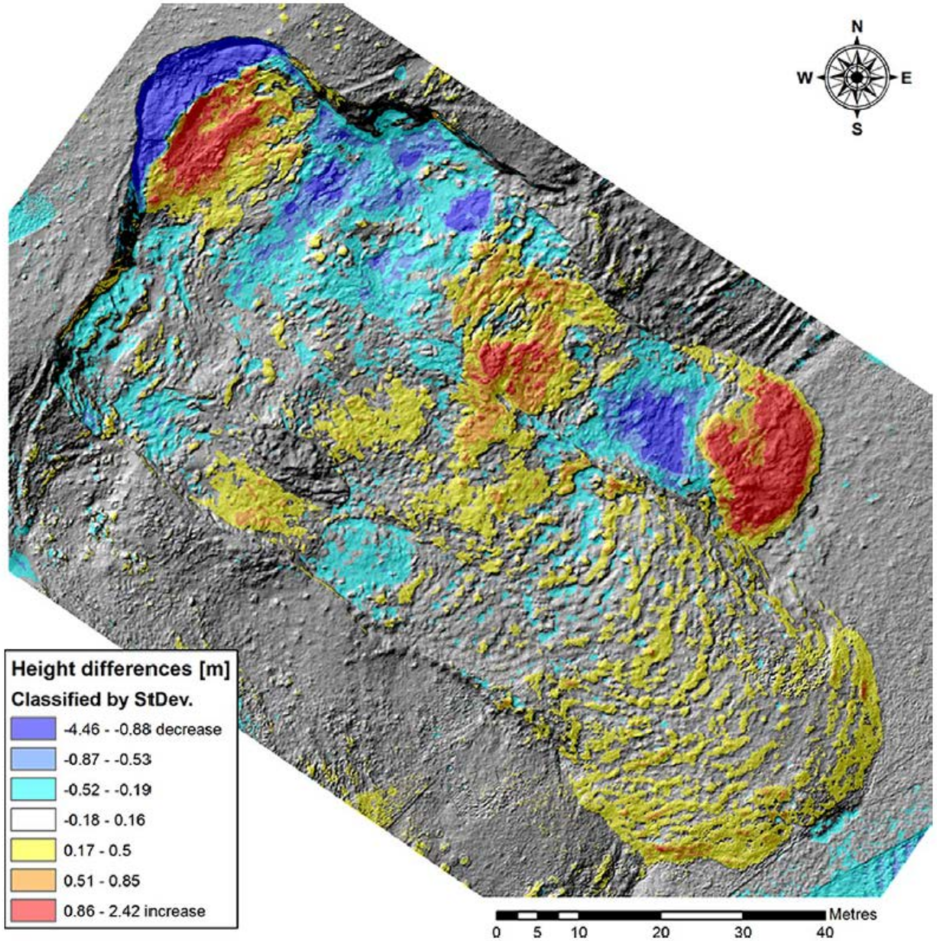
Home Hill landslide, Tasmania, surveyed with oktocopter in July and November 2011.

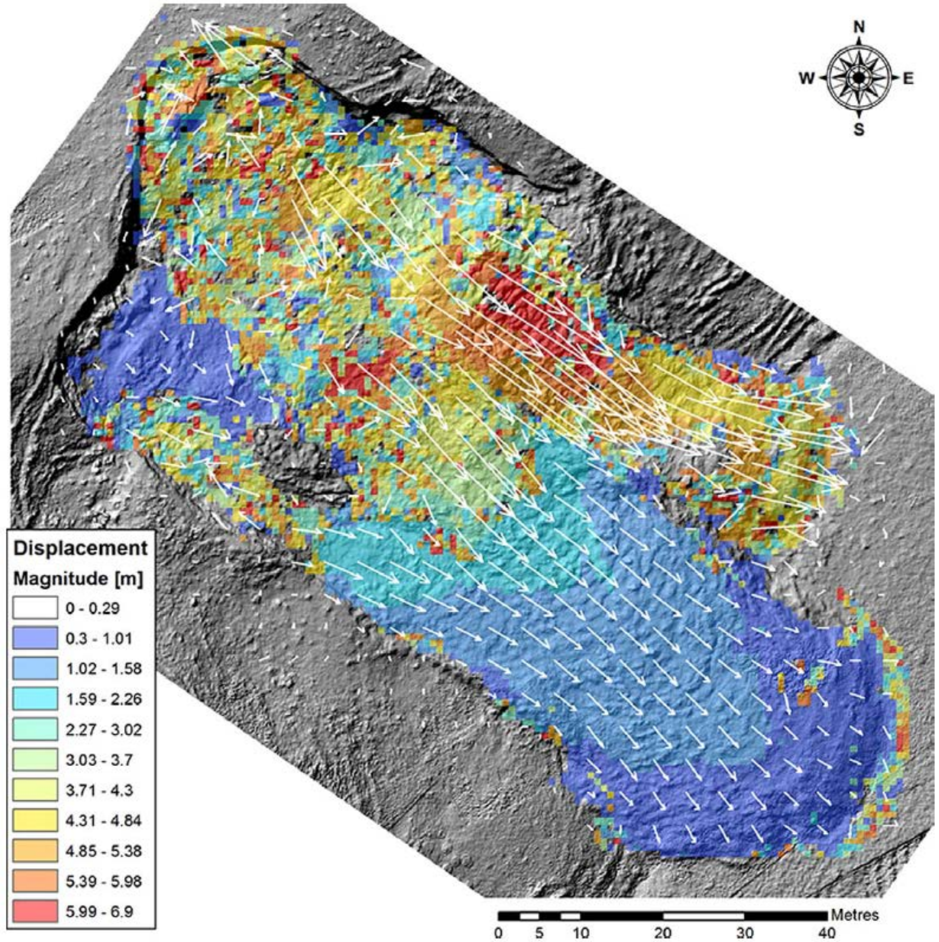
Lucieer *et al.* (2013). Mapping landslide displacements using Structure from Motion (SfM) and image correlation of multi-temporal UAV photography, *Progress in Physical Geography*

Landslide mapping

Left. DEM of Difference (DoD) from subtracting elevation grids

Right. Horizontal displacements from sub-pixel image correlation

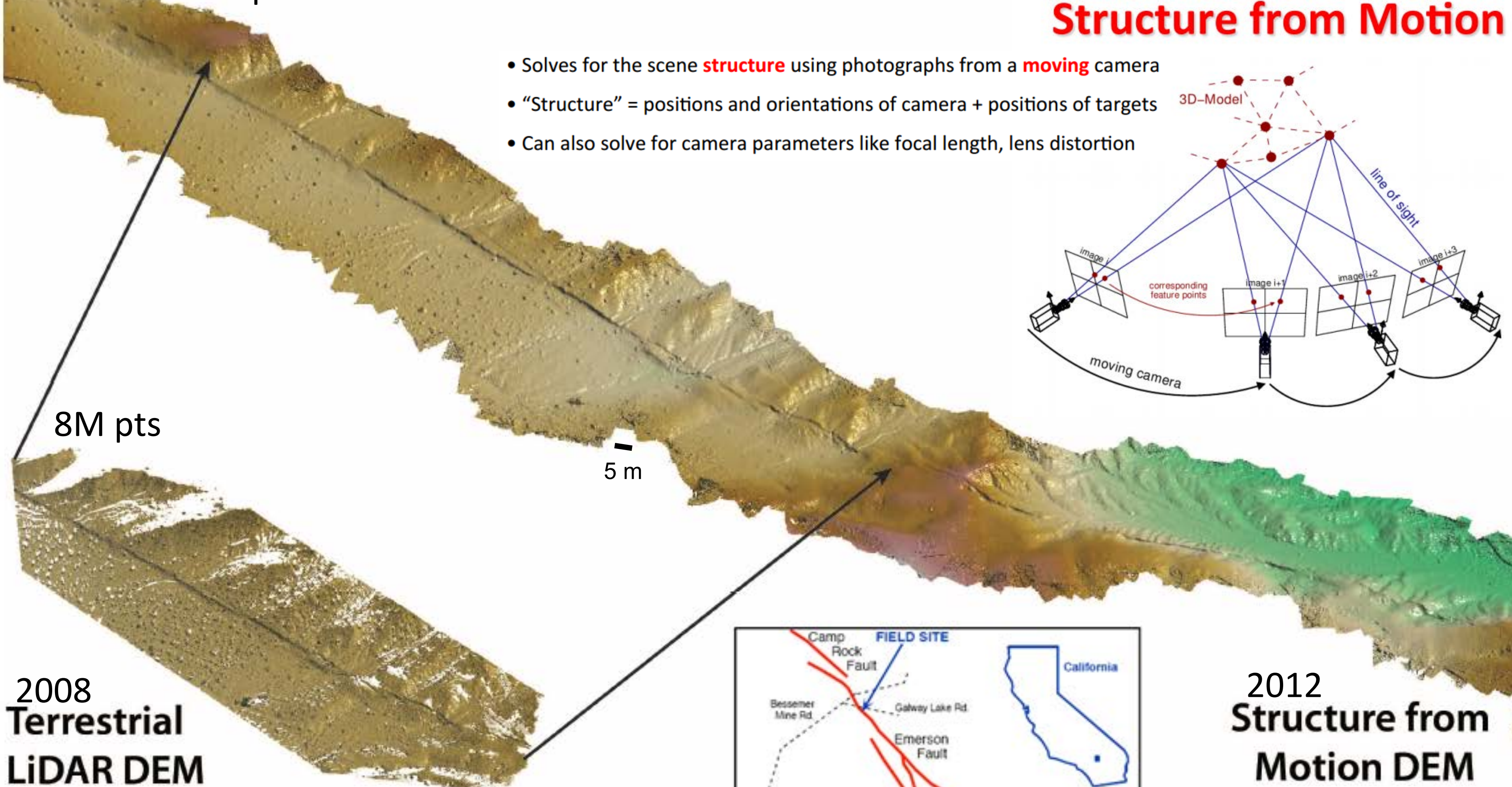




Lucieer *et al.* (2013). Mapping landslide displacements using Structure from Motion (SfM) and image correlation of multi-temporal UAV photography, *Progress in Physical Geography*

Structure from Motion

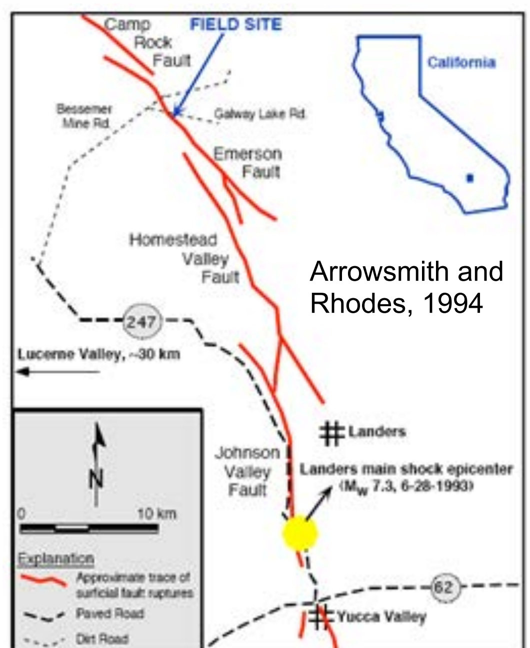
- Solves for the scene **structure** using photographs from a **moving** camera
- “Structure” = positions and orientations of camera + positions of targets
- Can also solve for camera parameters like focal length, lens distortion



2008
Terrestrial LiDAR DEM
Haddad, et al., 2012

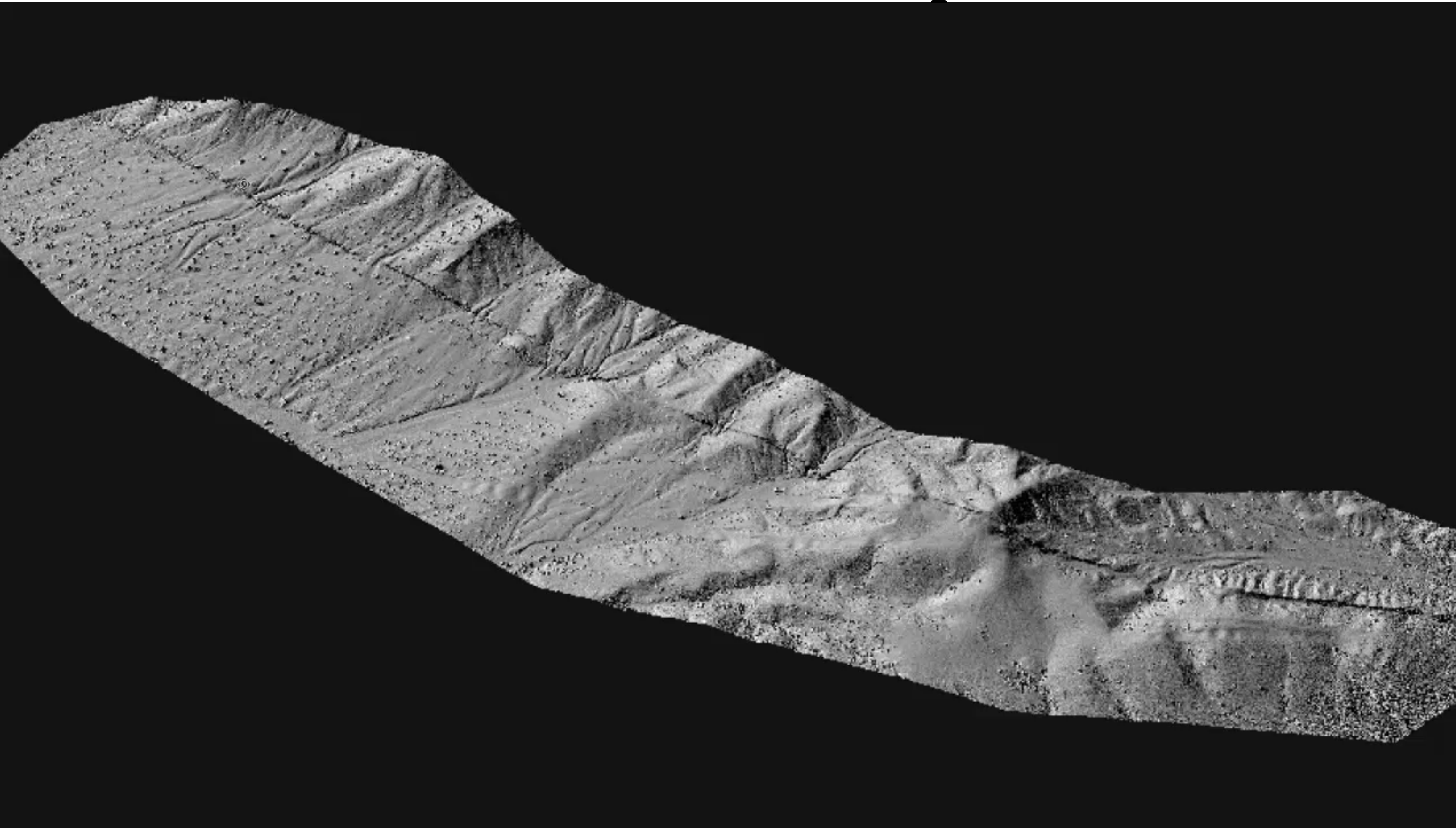
2012
Structure from Motion DEM
Johnson, et al. 2014

Landers, 1992 earthquake rupture repeated investigations on the decadal time scale: rupture zone sharp with secondary structures still evident

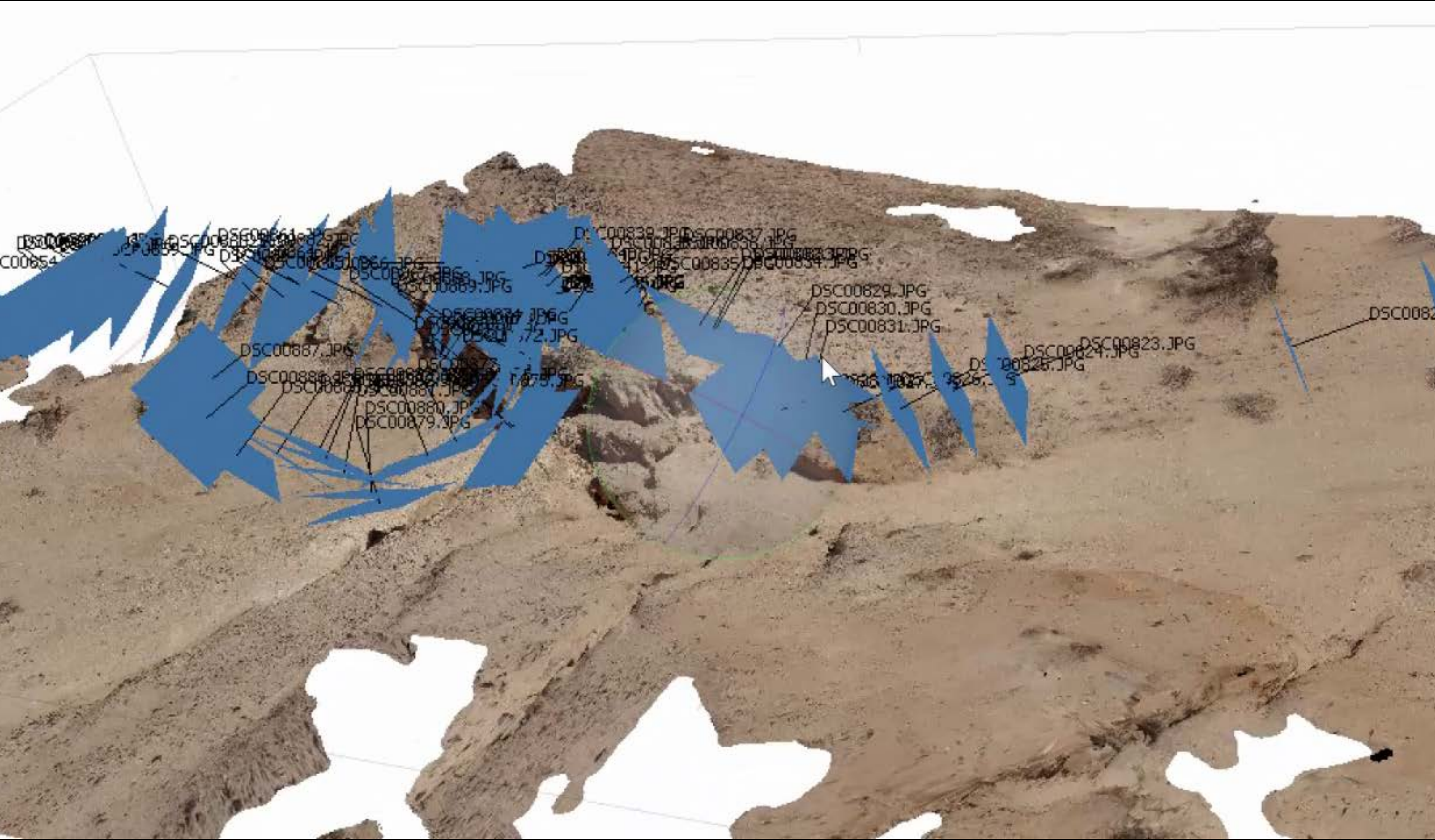


Arrowsmith and Rhodes, 1994

Landers surface rupture



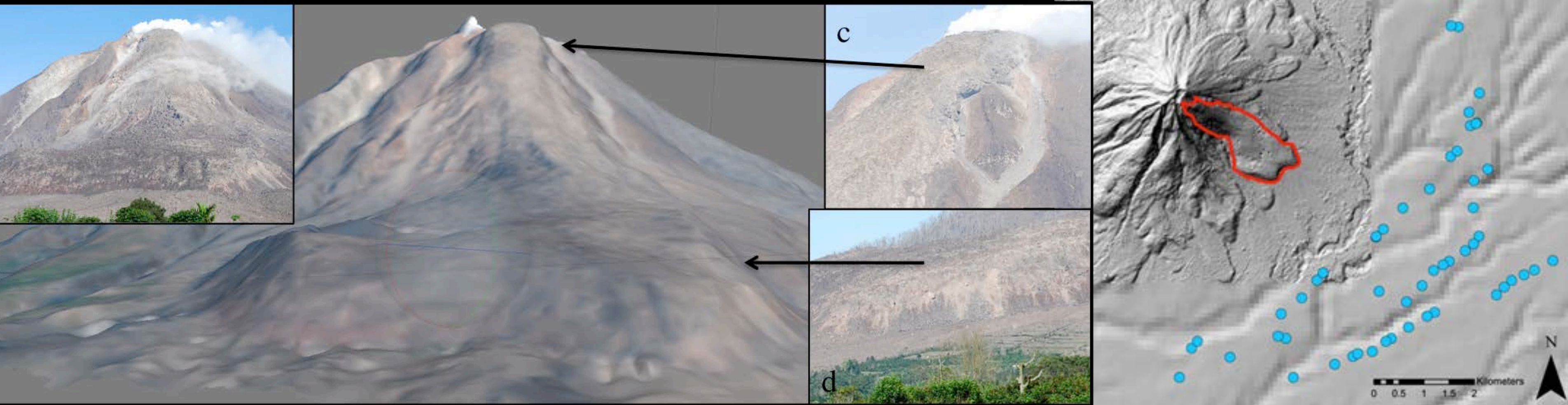
Johnson, K., Nissen, E., Saripalli, S., Arrowsmith, J R., McGarey, P., Scharer, K., Williams, P., Blisniuk, K., Rapid mapping of ultra-fine fault zone topography with Structure from Motion, *Geosphere,* v. 10; no. 5; p. 1-18; doi:10.1130/GES01017.1, 2014.

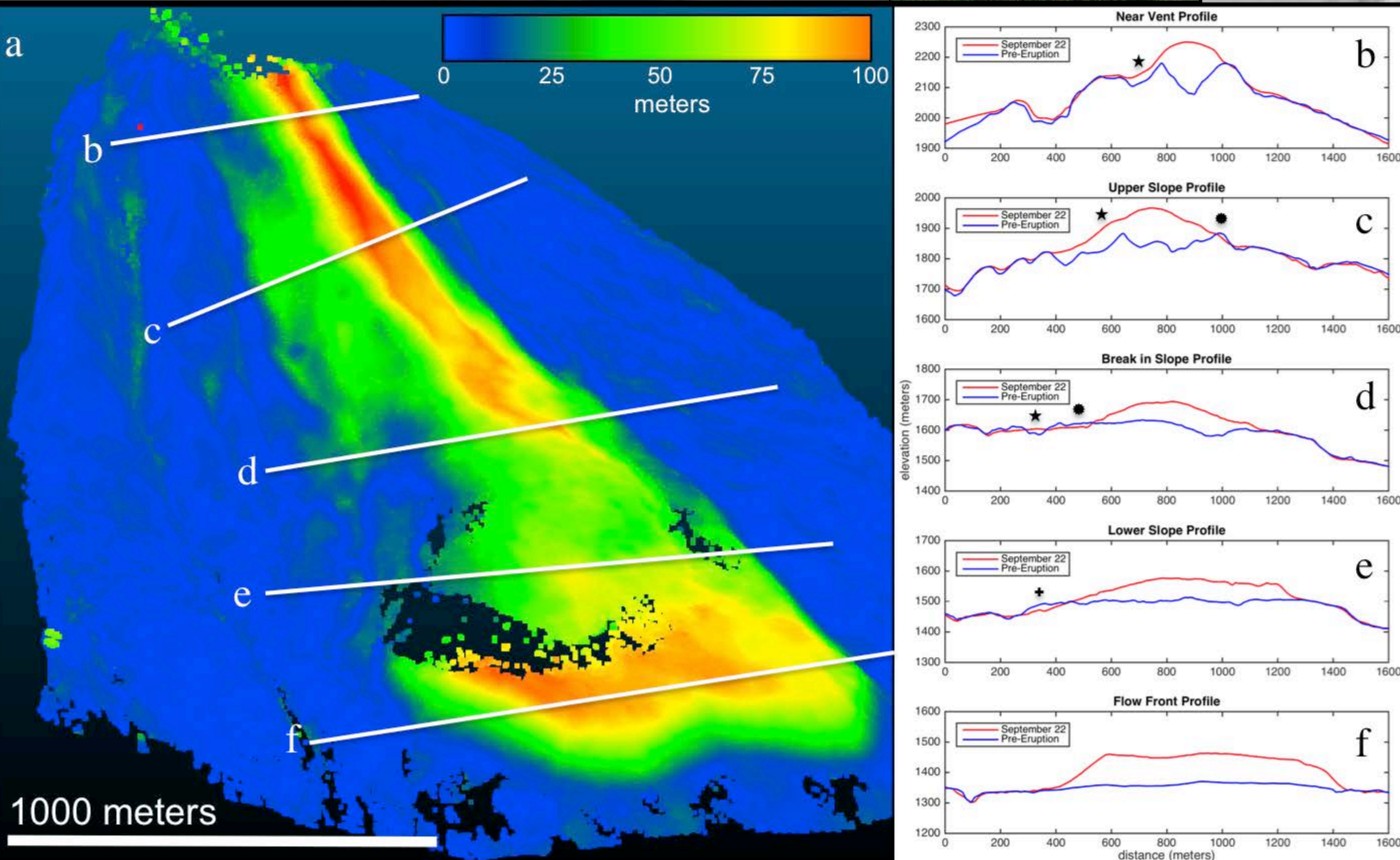


Ground-based structure from motion of Landers fault scarp knickpoint in 2016

Sinabung Indonesia

-simple ground based sfm and differencing for volcano study





The emplacement of the active lava flow at Sinabung Volcano, Sumatra, Indonesia, documented by structure-from-motion photogrammetry -Carr, et al., in review.

Pre-eruption 5 m DEM and post eruption SfM registered to unchanged areas

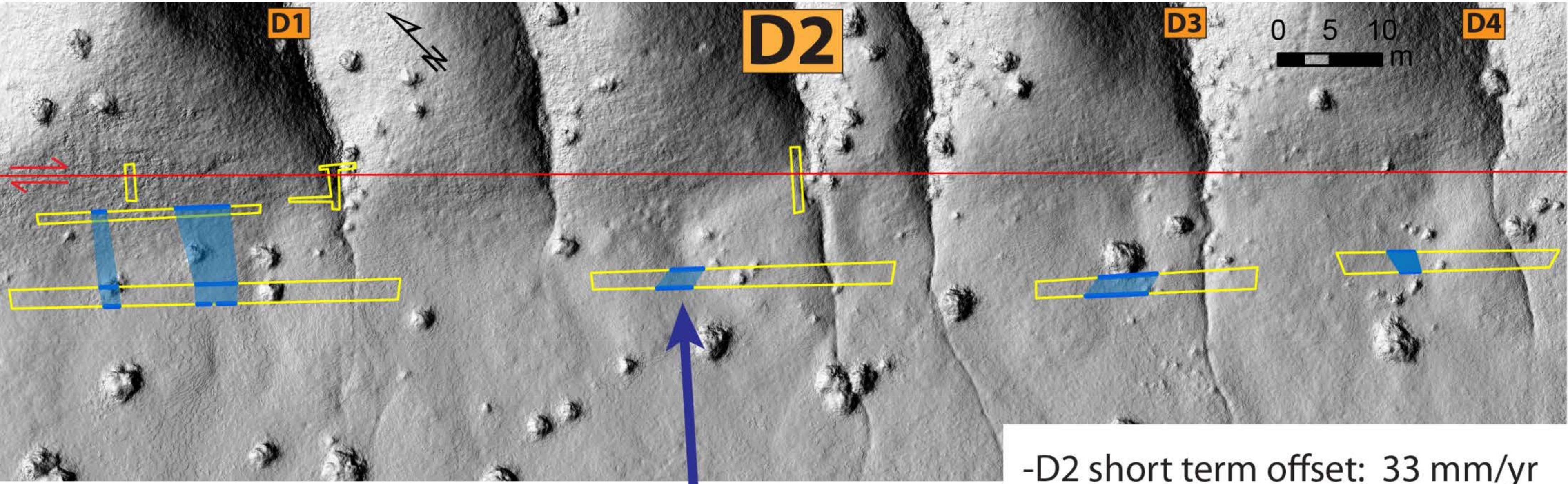
Van Matre Ranch California

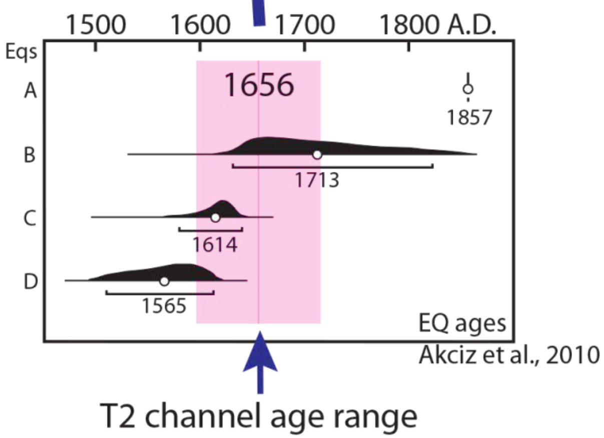
-high quality sfm for fine scale tectonic geomorphology

Van Matre Ranch: update on San Andreas Fault earthquake slip history with age control

-Salisbury, et al., in prep

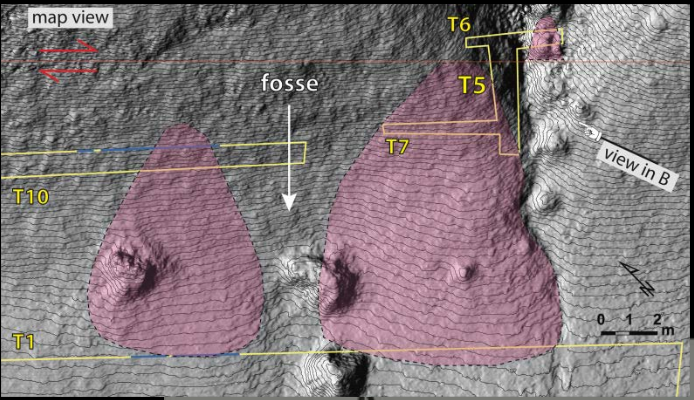
Van Matre Ranch: update on San Andreas Fault earthquake slip history with age control

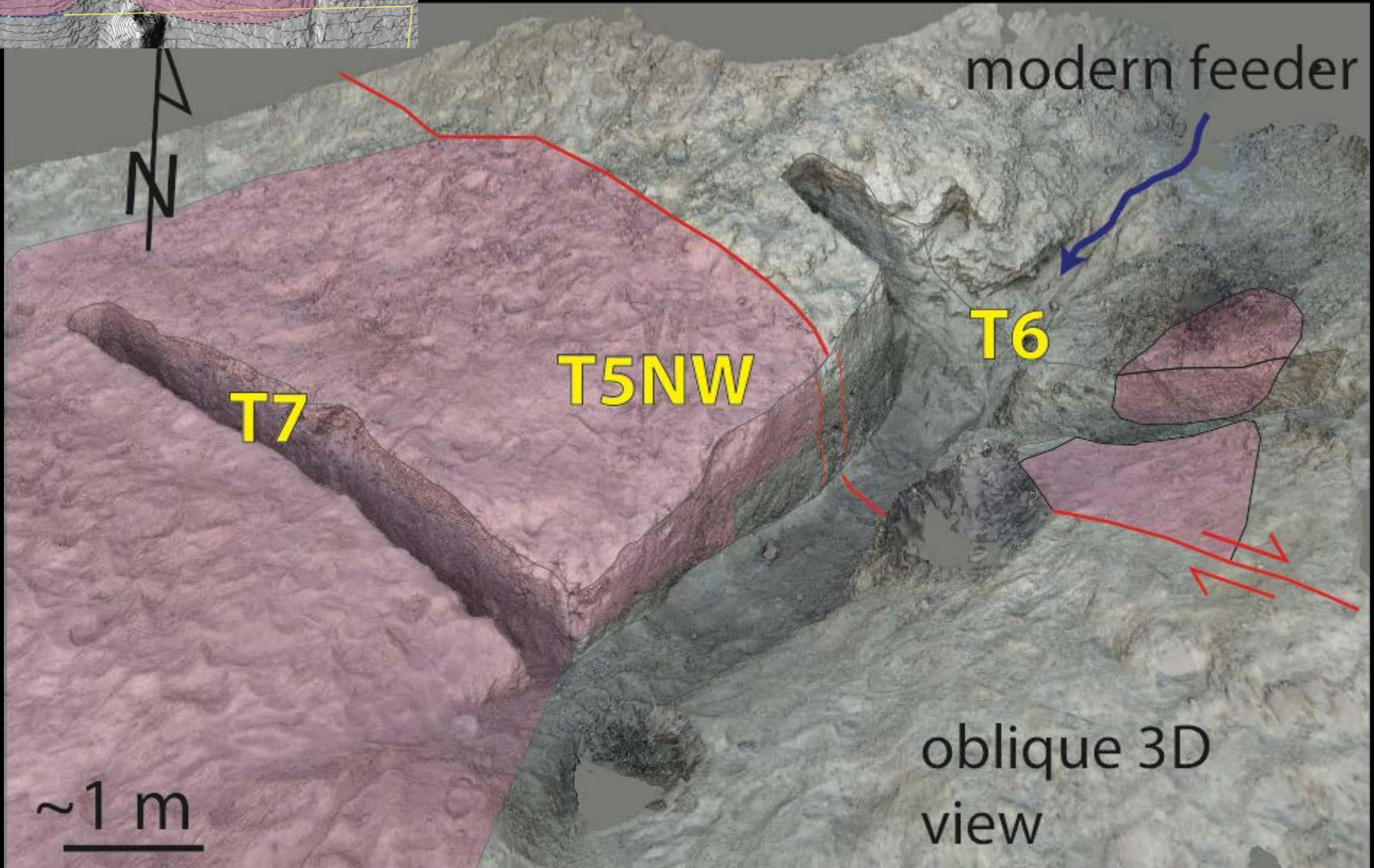




- -D2 short term offset: 33 mm/yr
- -Slip in 1857 = 3.8 m
- -Channels at D1, D3, and D4 are thousands of years too old to represent small offsets
- -up to 8 m of slip in penultimate event or 8 m of slip in previous 3 events

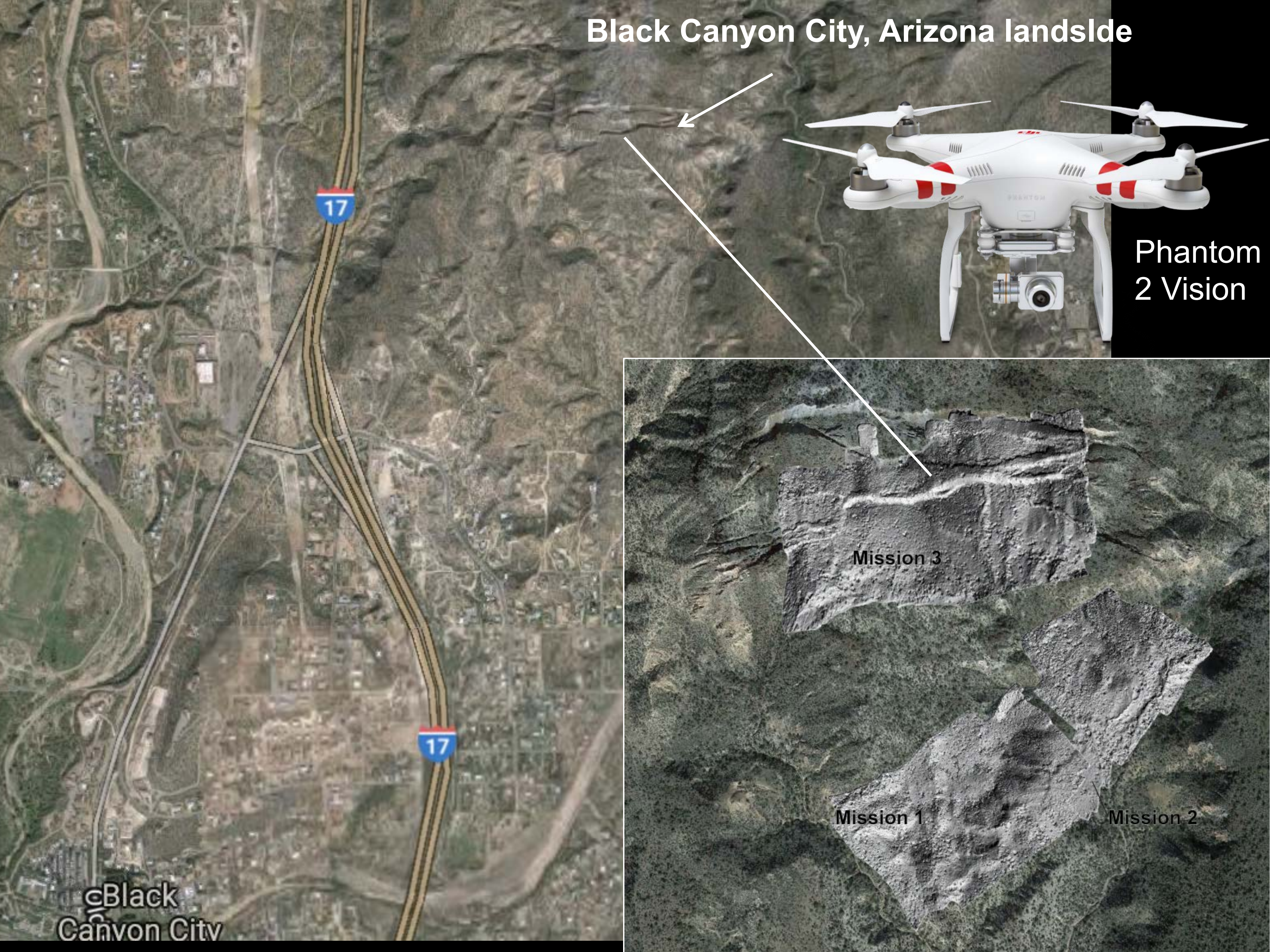
Slip in 1857 earthquake



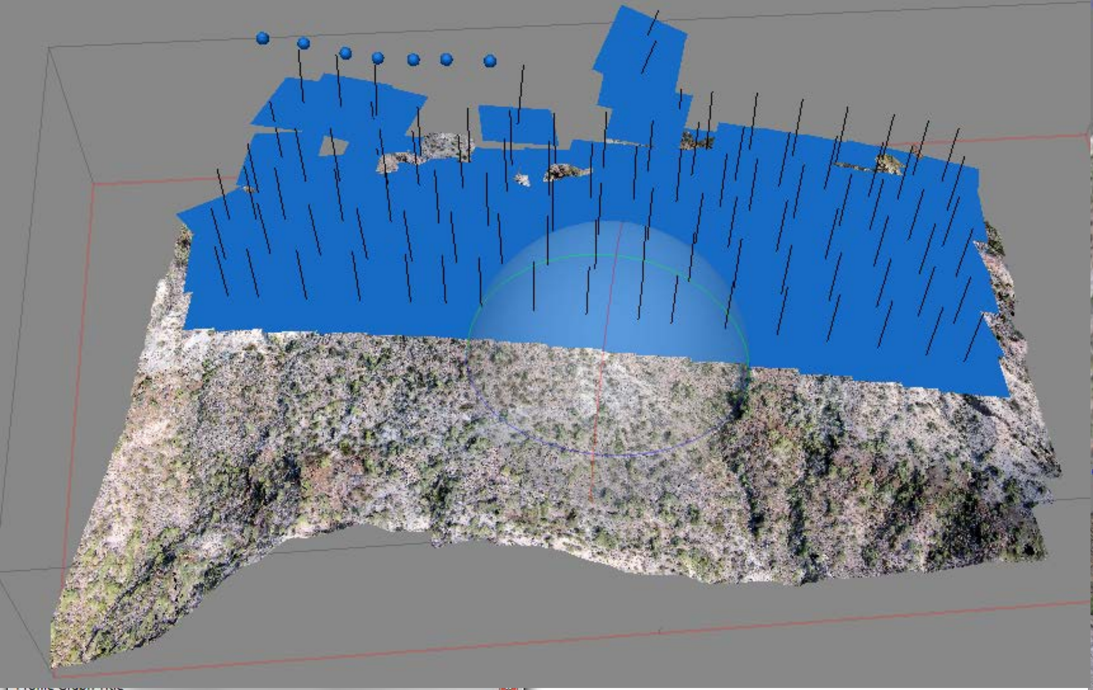


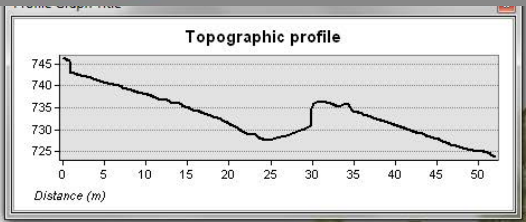
Black Canyon City Landslide, Arizona

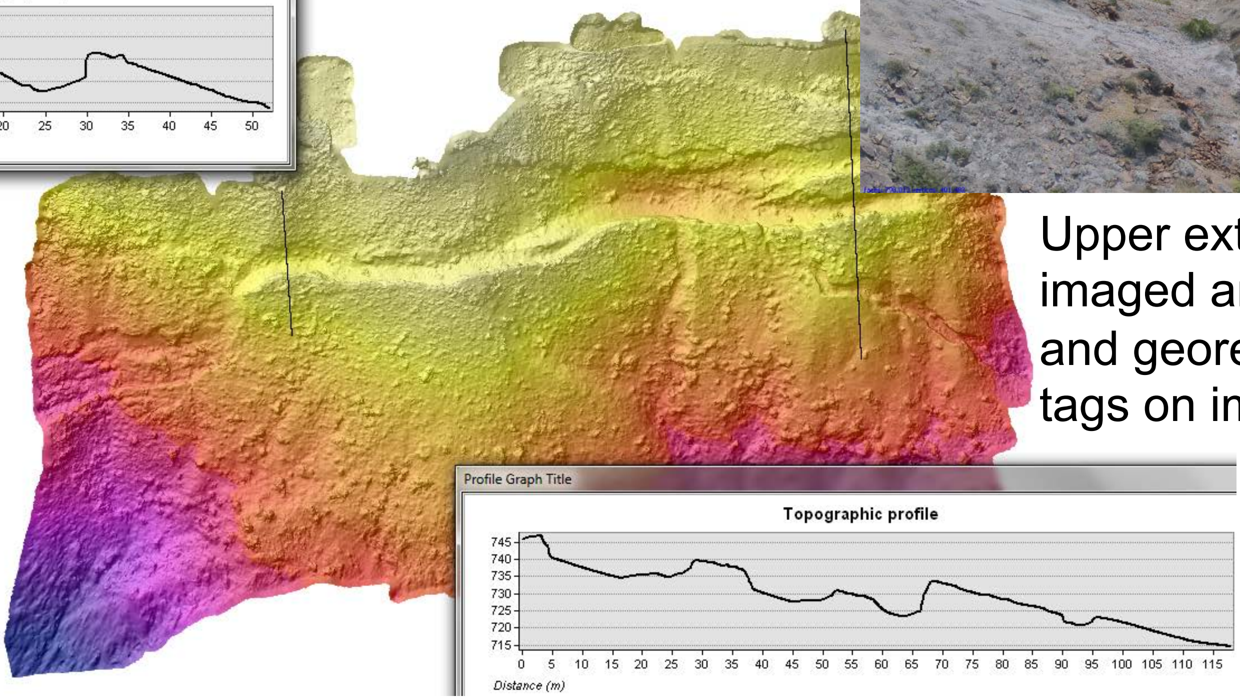
-SfM application for landslide study and georeferencing issues



Black Canyon City, Arizona landslde
Phantom 2 Vision
17
17
Mission 3
Mission 1
Mission 2
Black Canyon City

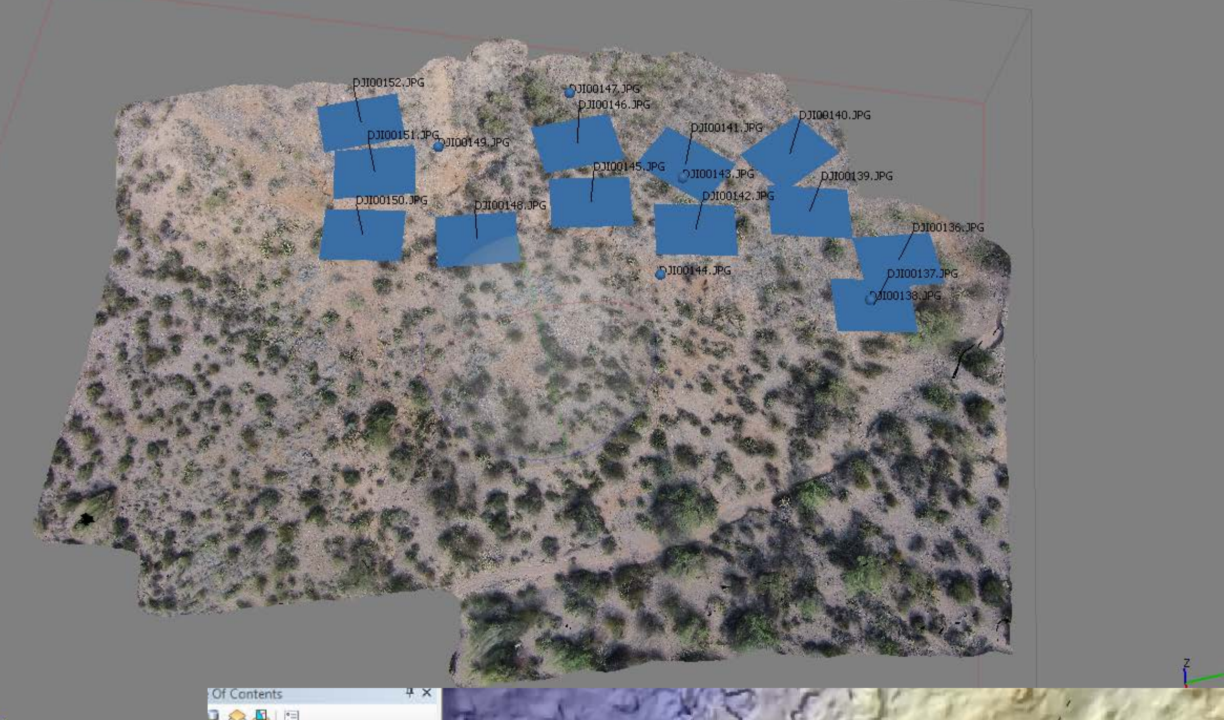


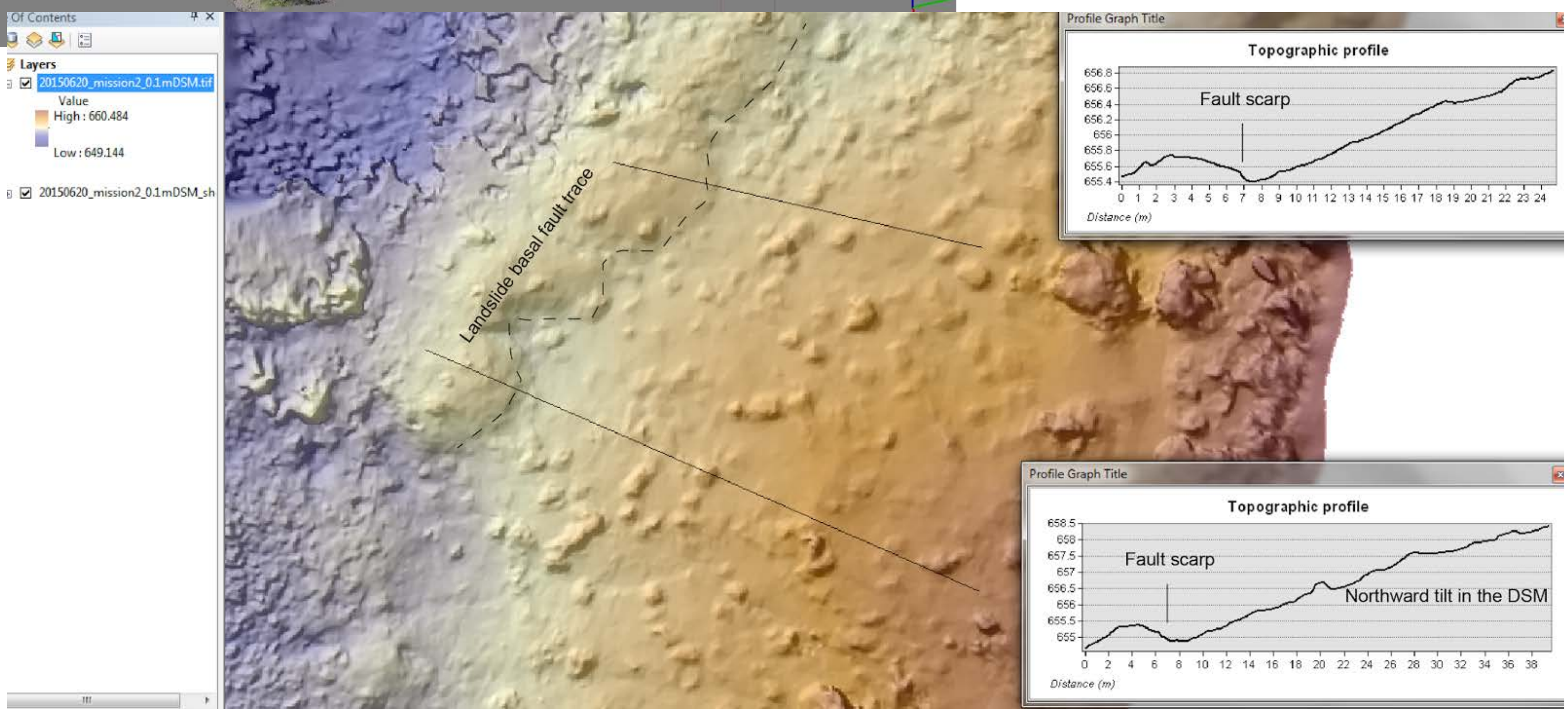




Upper extensional zone well imaged and ok orientation and georeferencing with gps tags on images only

Lower shortening zone ok imaged but orientation has major tilt with gps tags on images only





SfM from Video

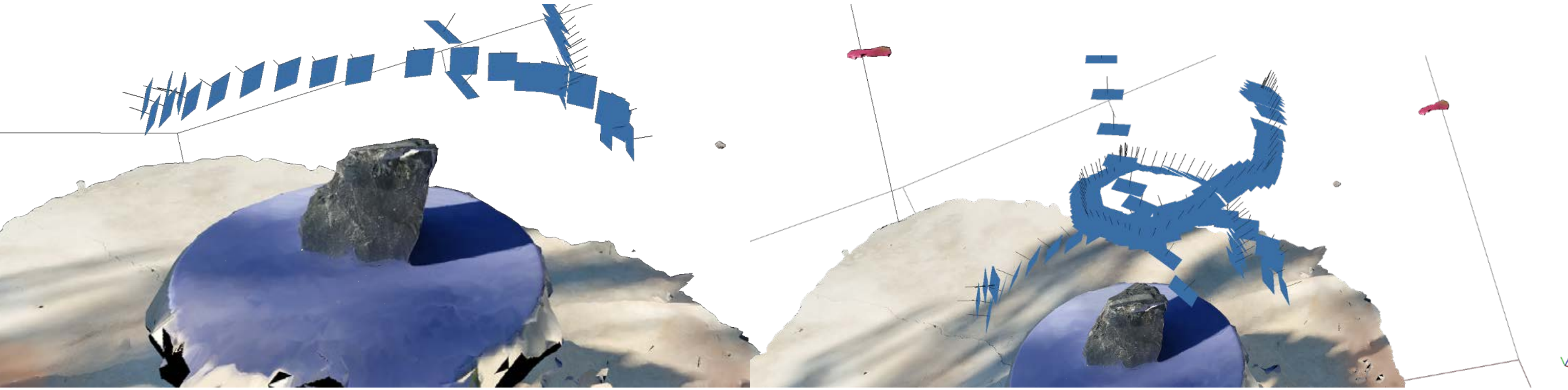
See also:
prompt 3D mapping of the earthquake-triggered lansdlide in Minami-Aso, Kumamoto, Japan

http://geomorphoto.blogspot.de/2016/04/prompt-3d-mapping-of-earthquake.html

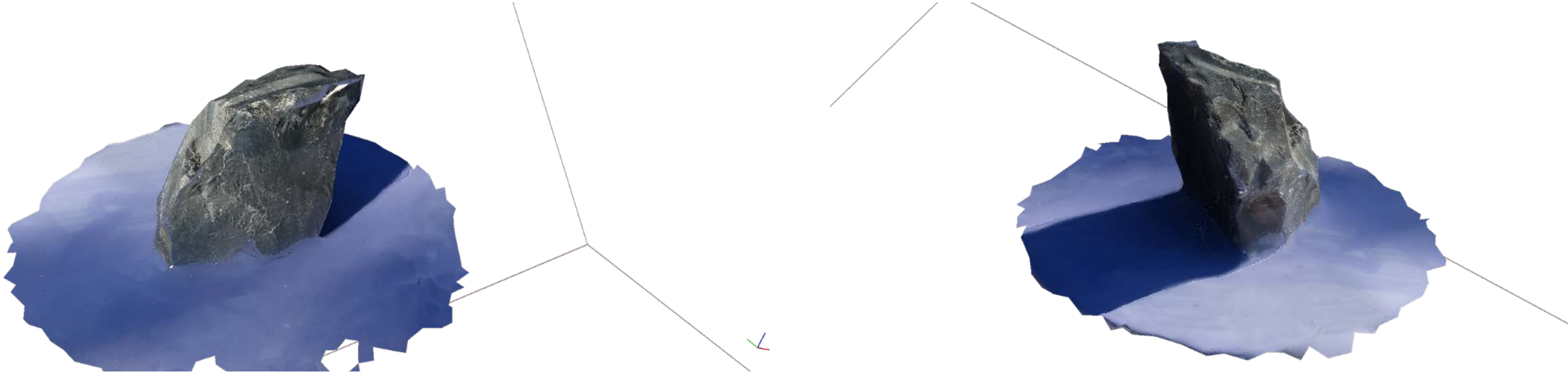
Grab 150 frames from the video (equally spaced in frame number)

See this blog entry:
http://activetectonics.blogspot.com/2017/10/structure-from-motion-using-video-from.html

I ran the files through the Agisoft Photoscan sequence of alignment (high), build dense cloud (medium), build mesh (medium), and build texture (medium).



Edit the resulting textured mesh in Agisoft Photoscan



SfM from Gazing Satellite Video

See also this blog entry:
http://activetectonics.blogspot.com/2017/10/structure-from-motion-using-video.html

Higher resolution and video

ALL IN THE FAMILY — PLANET TO LAUNCH SKYSATS AND DOVES ON MINOTAUR-C

Mike Safyan | September 26, 2017

[Planet Team](#) (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

SkySat-1 Video of Mount Ontake on October 16, 2014

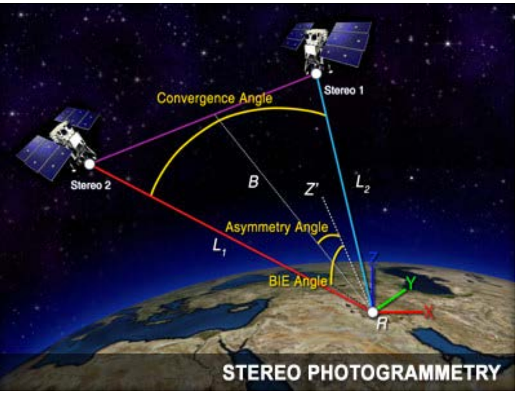
Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

Skybox Imaging HD Video of Mining Activity in Uşak, Western Turkey

Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

3D IMAGING WITH CAMERAS & LASERS

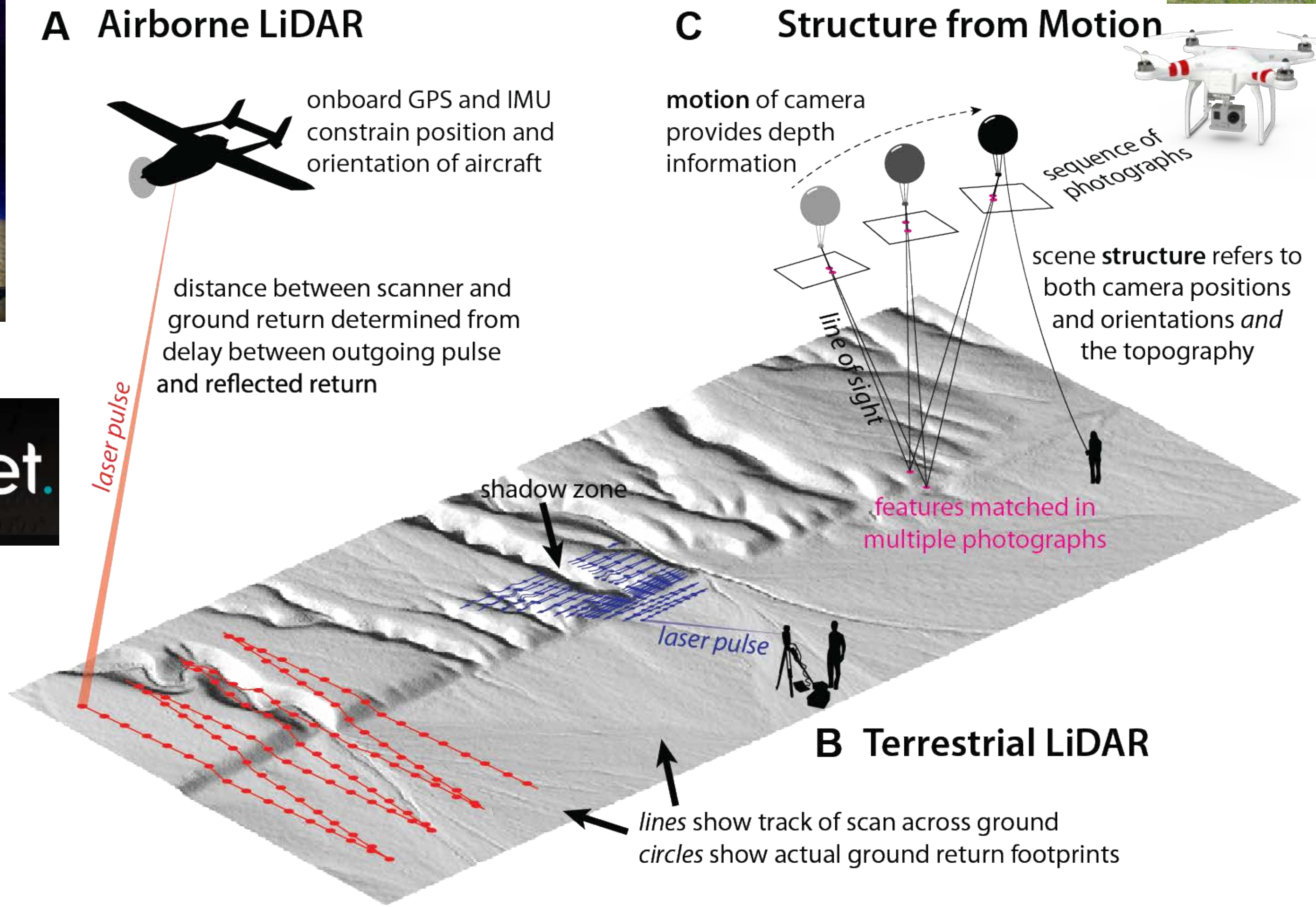
Space-based



DigitalGlobe

planet.

polar geospatial center



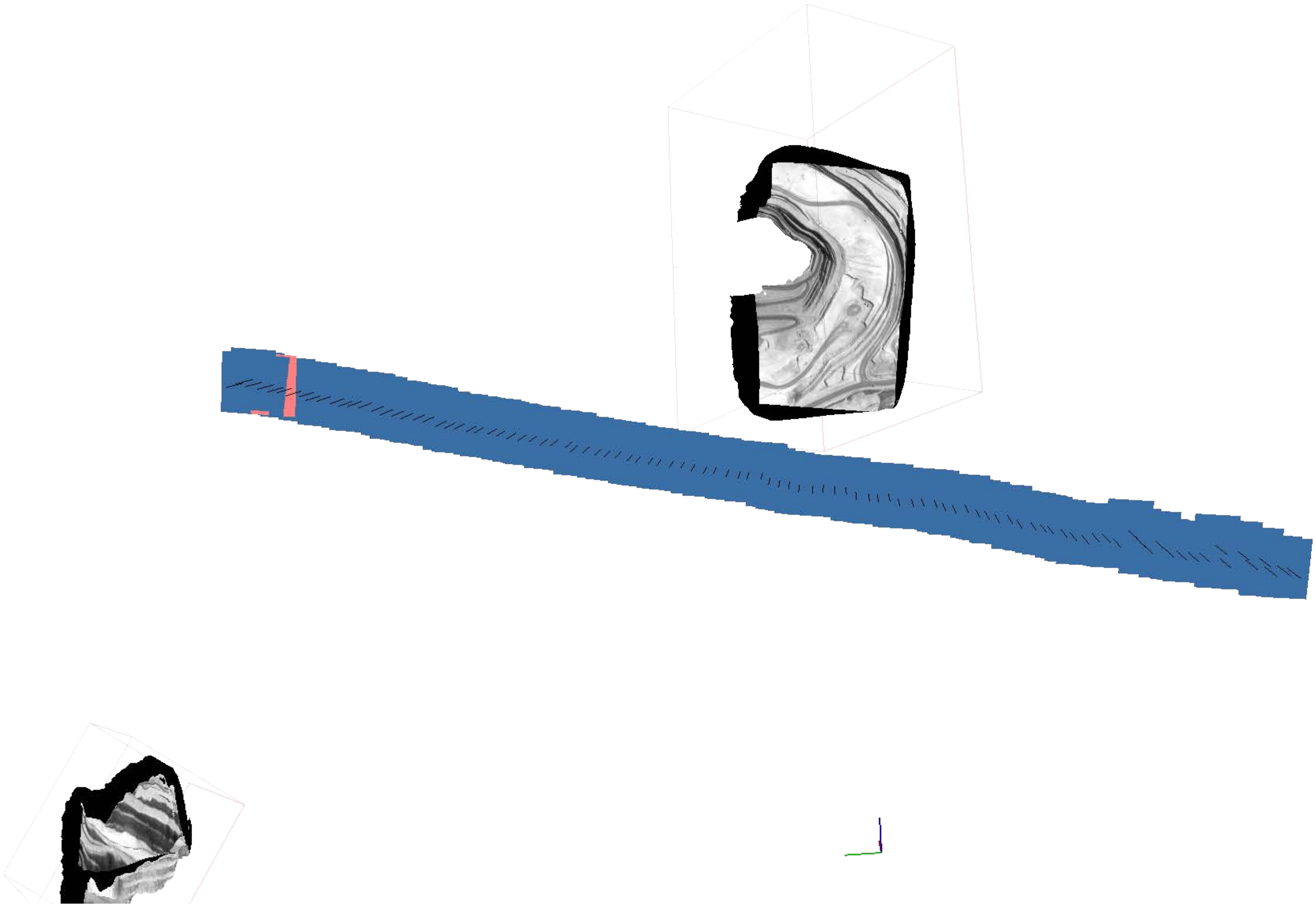
Johnson et al., Geosphere, 2014

Need ~meter-scale sampling to cover critical scale breaks and temporal repeat to address log(t) response of some phenomena

Grab 100 frames from the video

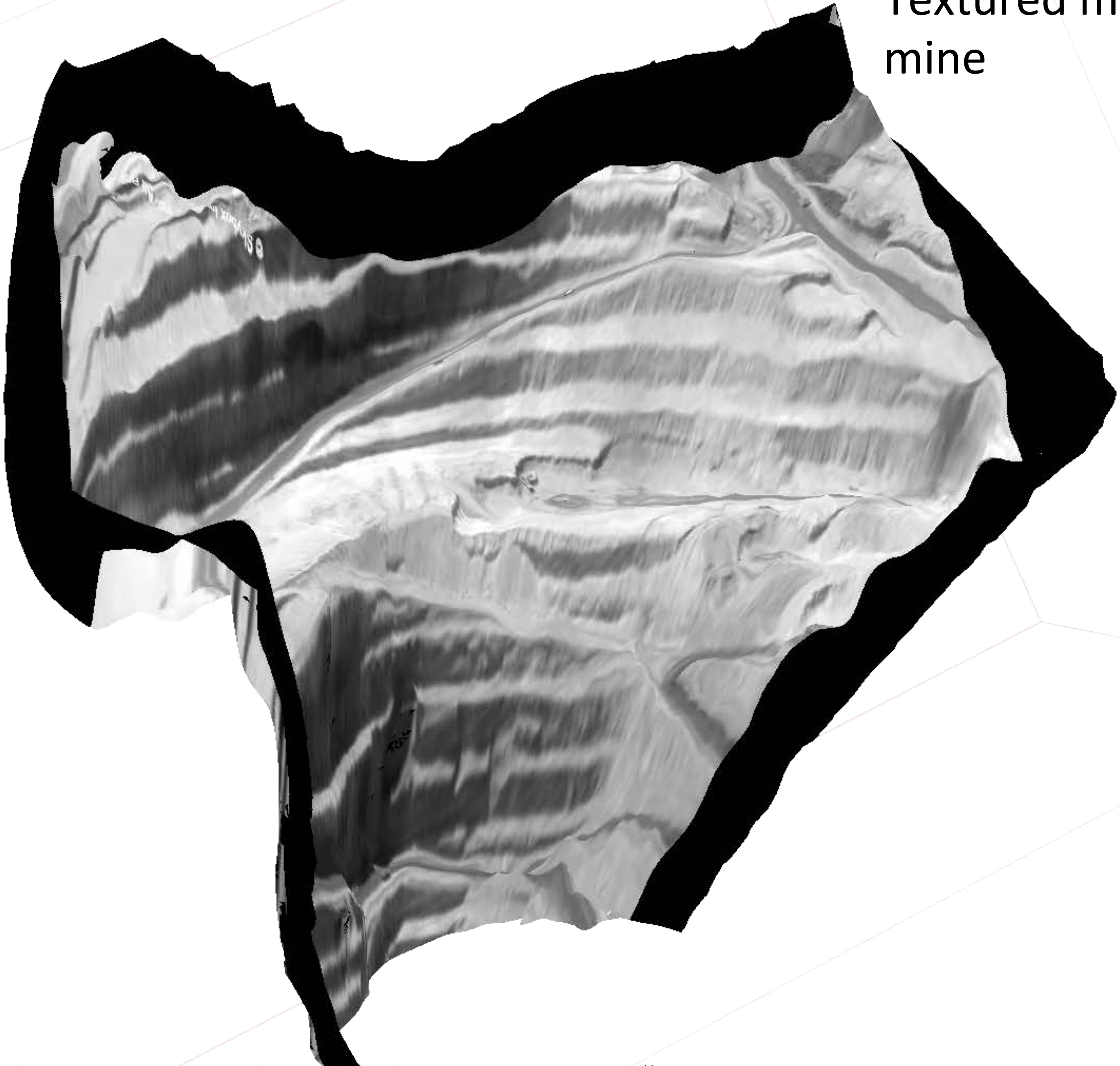
Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

Photoscan views from the side and the top of the mine



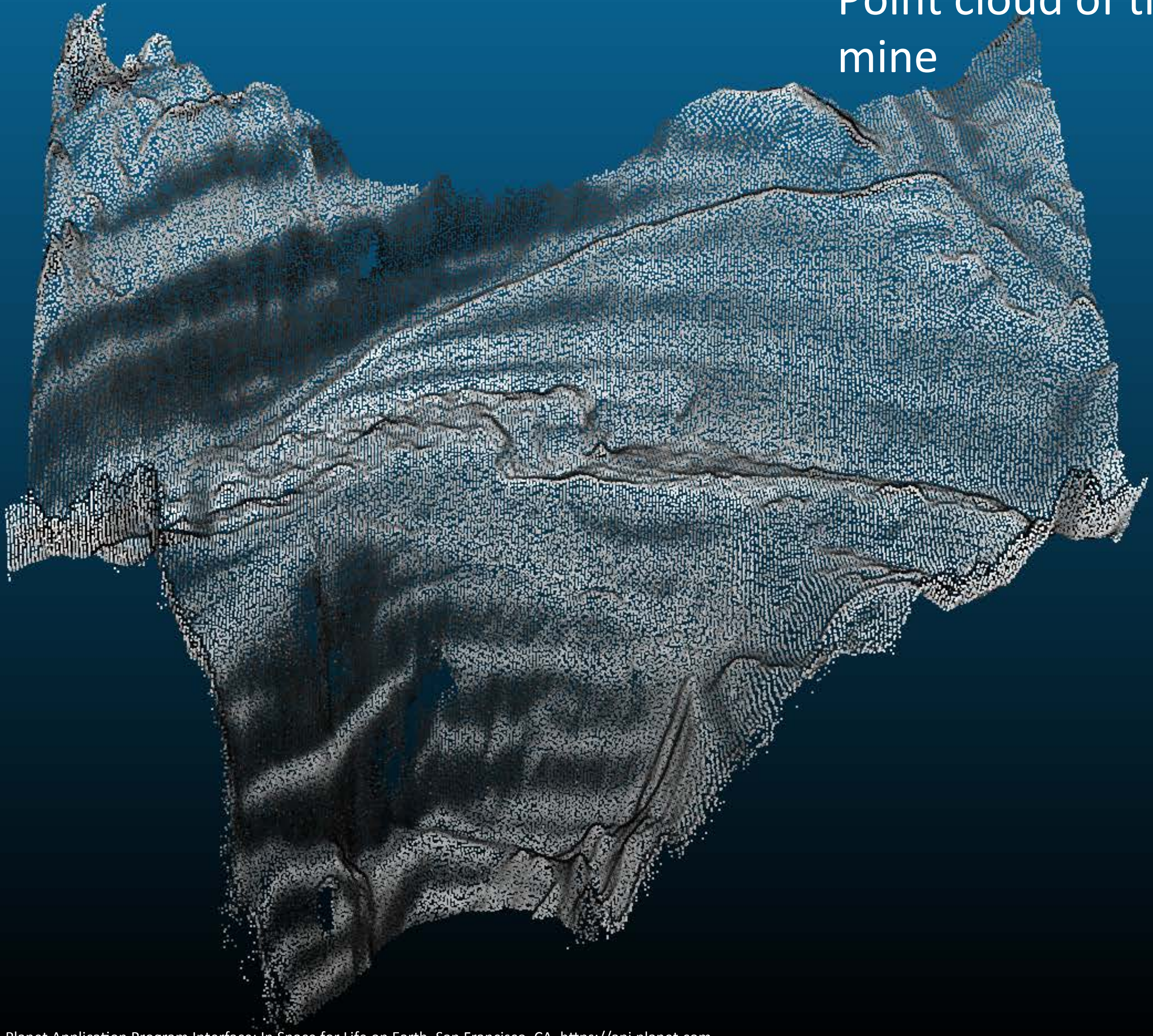
Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

Textured mesh of the mine

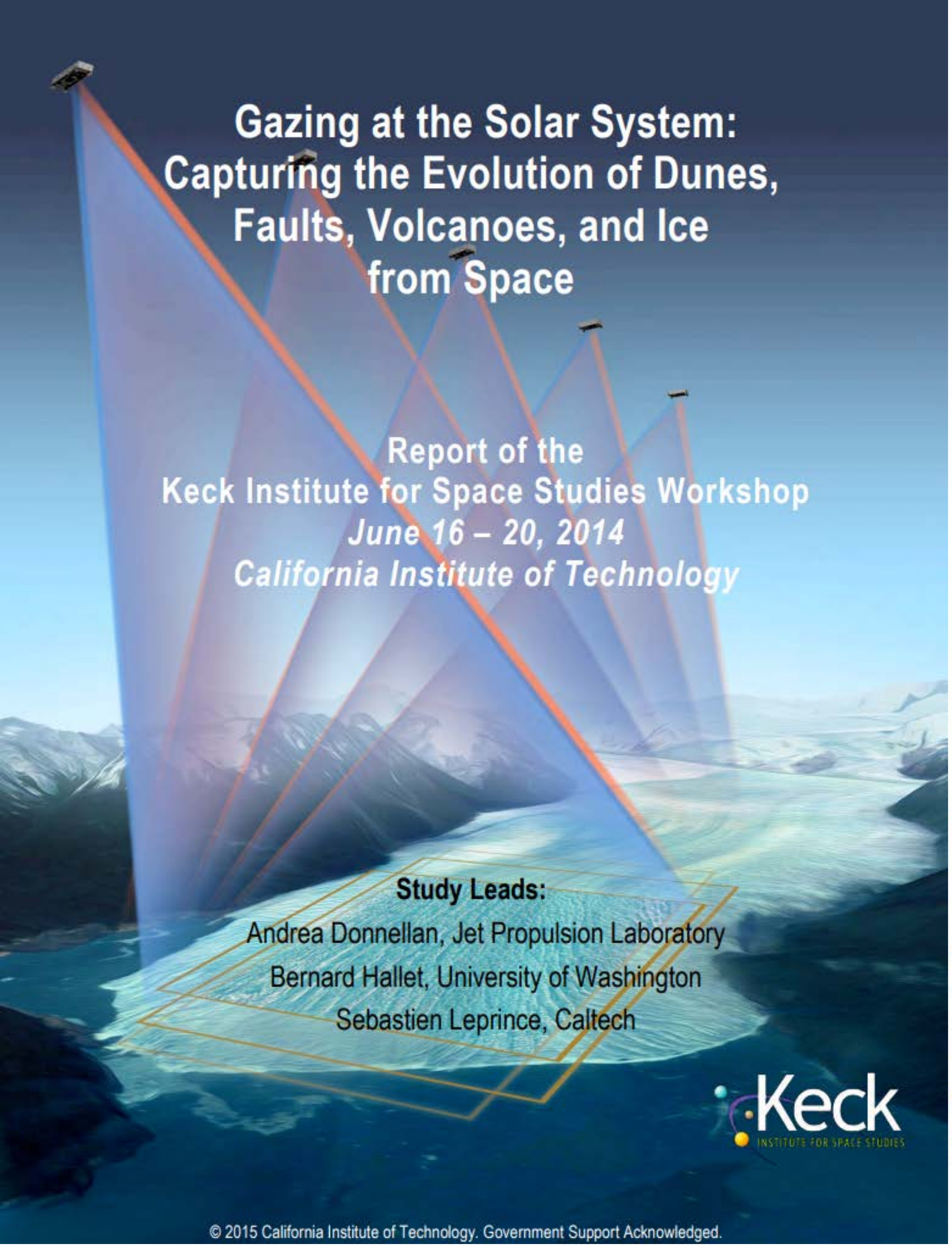


Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.

Point cloud of the mine



Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.



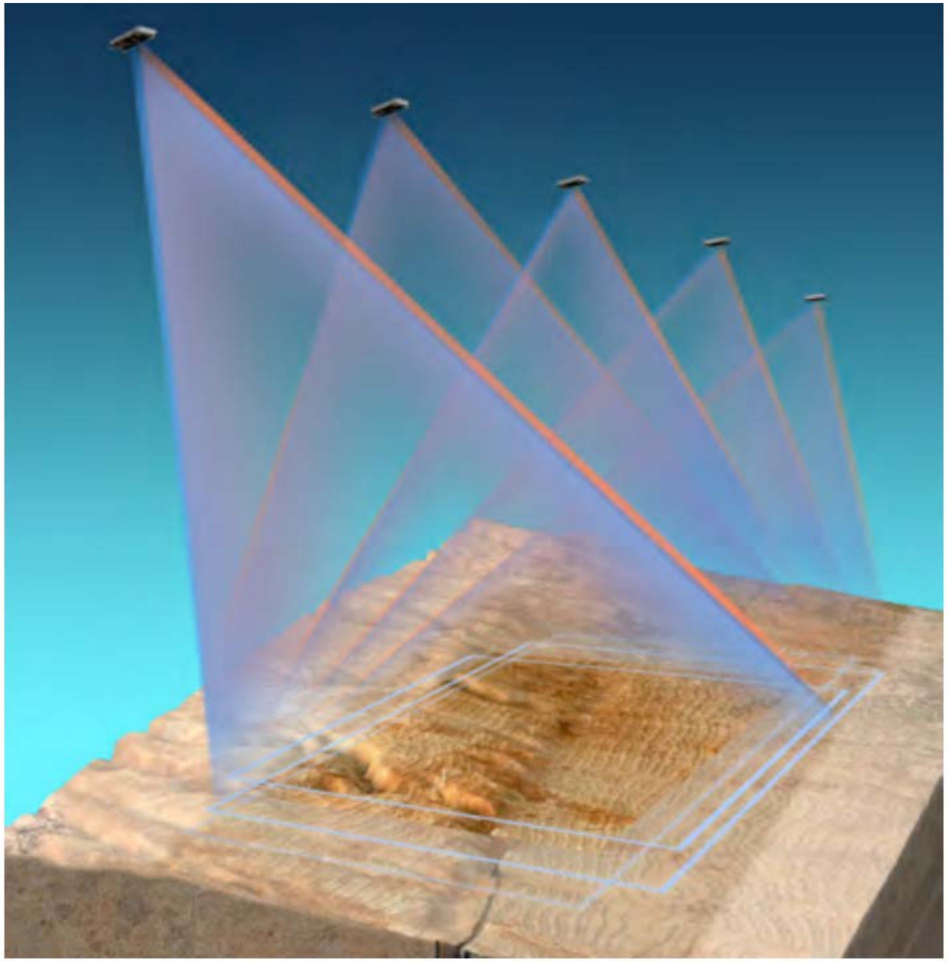
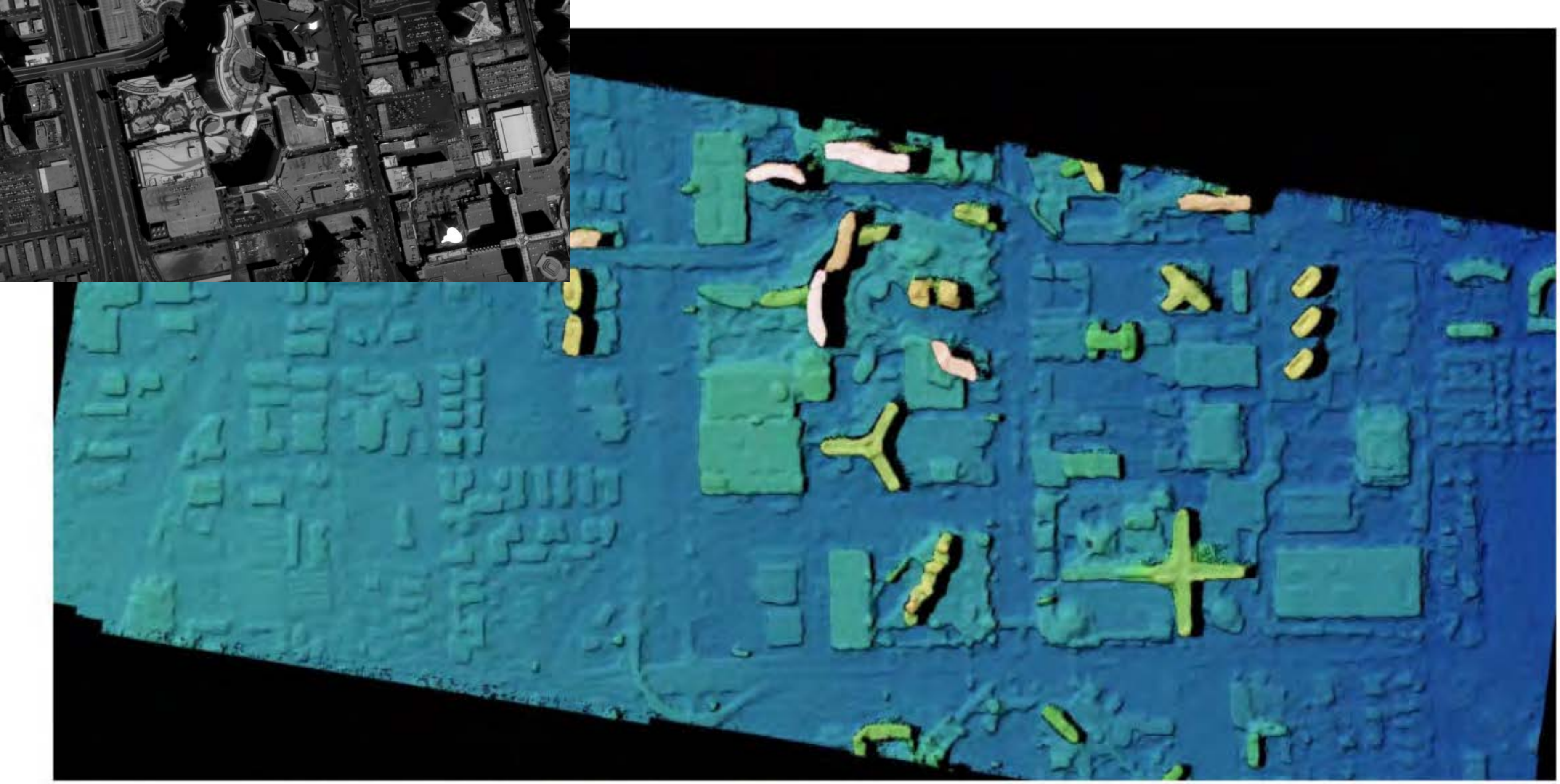


Figure 1. A gazing instrument would stare at and track targets from a range of vantage points during a single pass. For certain orbits solar illumination would vary between passes.

Idea of gazing has been proposed



AD+Census, Small Adaptive Support Regions + Total Variation (Huber) regularization

Figure 19. DSM extracted using 21 images (1 master and 20 slaves) from a Skybox sequence acquired above Las Vegas Extraction using semi-global matching and Total Variations (TV) regularization and median DSM stacking, courtesy of P. d'Angelo, DLR.

-Keck report, 2014

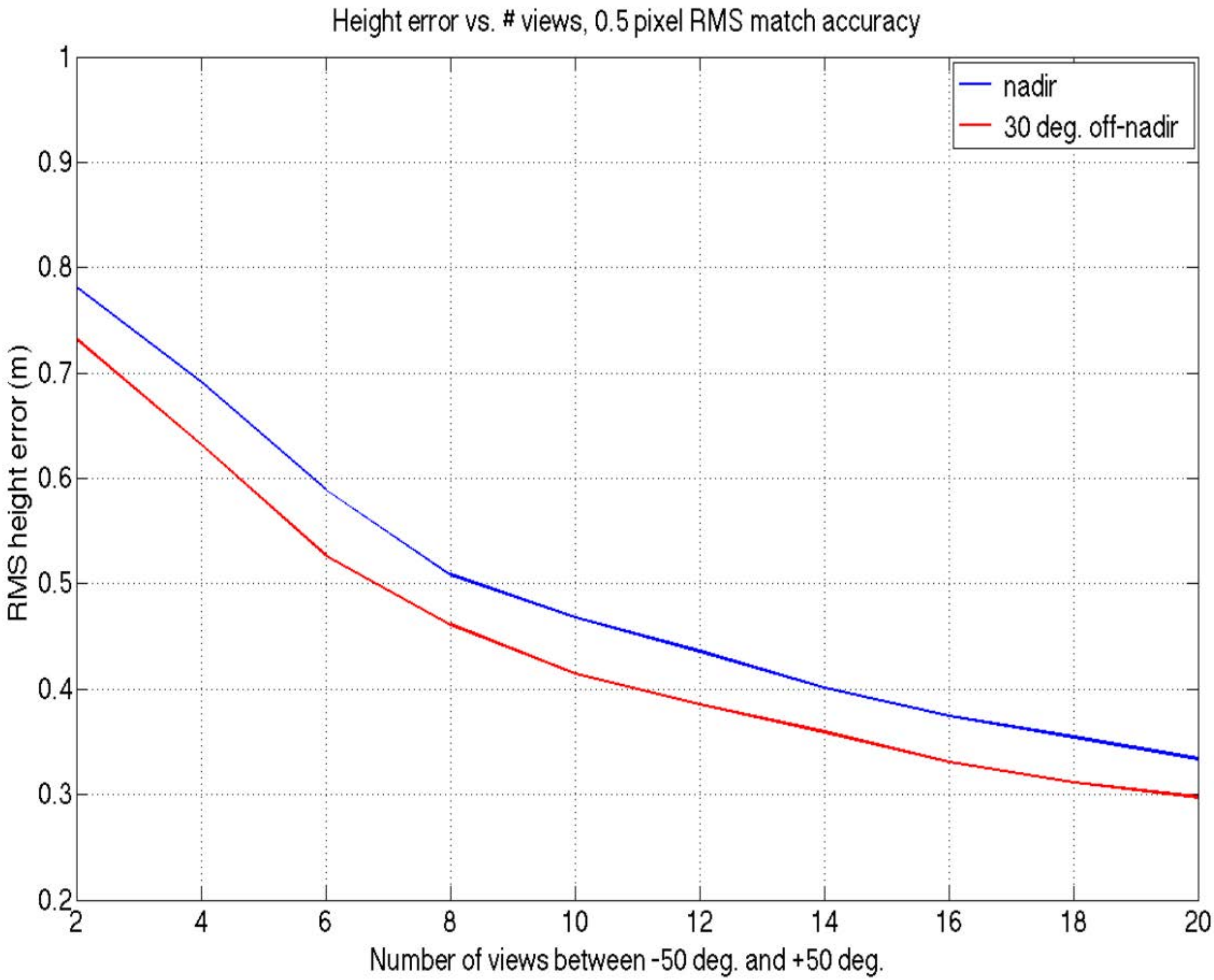
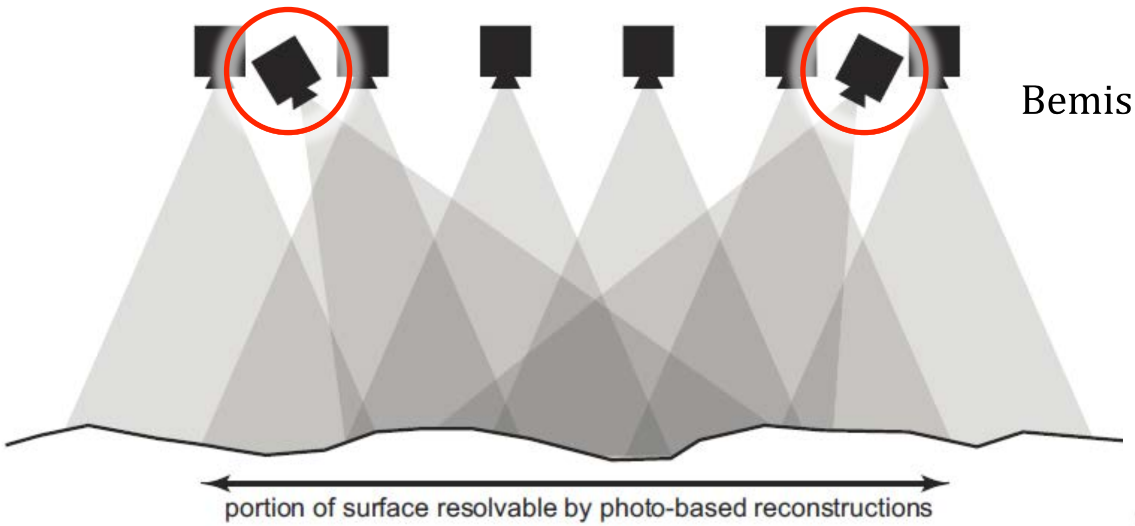


Figure 20. Monte-Carlo simulation for 12MP sensor at 0.3 deg FOV, at 400km orbit. 1σ simulated range resolution is shown as a function of number of views between -50 deg. and +50 deg. Nadir and 30 deg. off-nadir passes are shown.

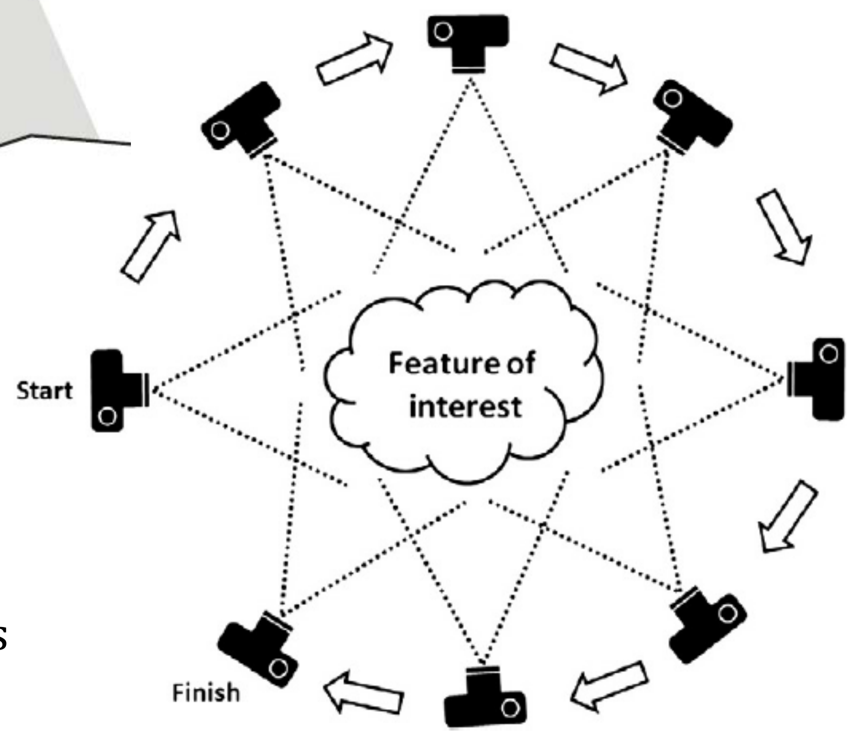
SfM lunch exercise

Build your own model using your own photographs of a target on campus.
Make sure you have a way of transferring your photos onto the computer!



Bemis *et al.* (2014).

Westoby *et al.* (2012).



Tips

- Choose a target with some texture
- Ensure plenty of overlap between photos
- Capture the target from a variety of angles
- Try to capture the object in ~20 – 30 photos