Metadata Report

Project Name

Parkway Drive Landslide, North Salt Lake City, Davis County, Utah, 2015 Aerial Imagery

Summary

The Utah Geological Survey (UGS), in partnership with the Brigham Young University (BYU) Engineering Department, used a custom eight propeller unmanned aircraft to acquire data over the Parkway Drive landslide in North Salt Lake, Davis County, Utah. The partnership goal was to document and generate a structure from motion model for further landslide analysis.

Personnel

- PI(s)

Gregg Beukelman (UGS retired) and Ben Erickson (benerickson@utah.gov)

- Field staff

Gregg Beukelman (UGS retired) and Ben Erickson (benerickson@utah.gov)

- Additional team members

BYU Pilot (student) and BYU Graduate students (3)

Site Information

- Site description

Located in a residential area in the city of North Salt Lake, Utah. Predevelopment, the land was used as an aggregate gravel pit.

- Site objective

Fly a high resolution still camera over the landslide area to create a structure from motion model.

- Site location (GPS cords and/or map)

40.8272814°, -111.9025228°

- Site conditions

Weather conditions were clear and calm.

- Date/time spent at each site

June 20, 2015

Survey Results

- Equipment used

Custom built eight propeller unmanned aircraft with a mounted DSLR NIKON D7100 camera. High precision GPS R8 GNSS receiver using VRS base corrections for ground control.

- GPS solutions

Nine ground control points were used for model correlation. The ground control points were located using a Trimble R8 GNSS receiver and the Utah TURN VRS base network. The resulting locations are in UTM NAD83 Zone 12 coordinate system projection.

- Errors

The overall ground control total error was 3.65 cm, with X=2.08 cm, Y=2.37 cm, and Z=1.82 cm errors, respectively.

- Alignments
- Collection methods

682 photos out of 700 photos were used in the generation of the structure from motion model. The flying altitude was 85.9 m above ground surface.

Products

- Date of dataset collection

6/20/2015

- Coordinate system of datasets

NAD83 / UTM Zone 12N (EPSG:26912)

- Spatial resolution

Ground resolution: 9.24 mm/pix, DEM Resolution: 3.7 cm/pix, Point density: 732 points/m²

- Horizontal Accuracy

X=2.08 cm, Y=2.37 cm

- Vertical Accuracy

Z=1.82 cm

- Data formats

Point cloud is packaged in a LAZ format. DEM and orthomosaic are GeoTIFF format.

- Data processing methods

Products were produced using Agisoft Photoscan Professional.

Misc Notes

For full datasets or original images, please contact Ben Erickson (benerickson@utah.gov).

Parkway Drive Landslide 2015

Agisoft Processing Report

11 December 2019

Survey Data

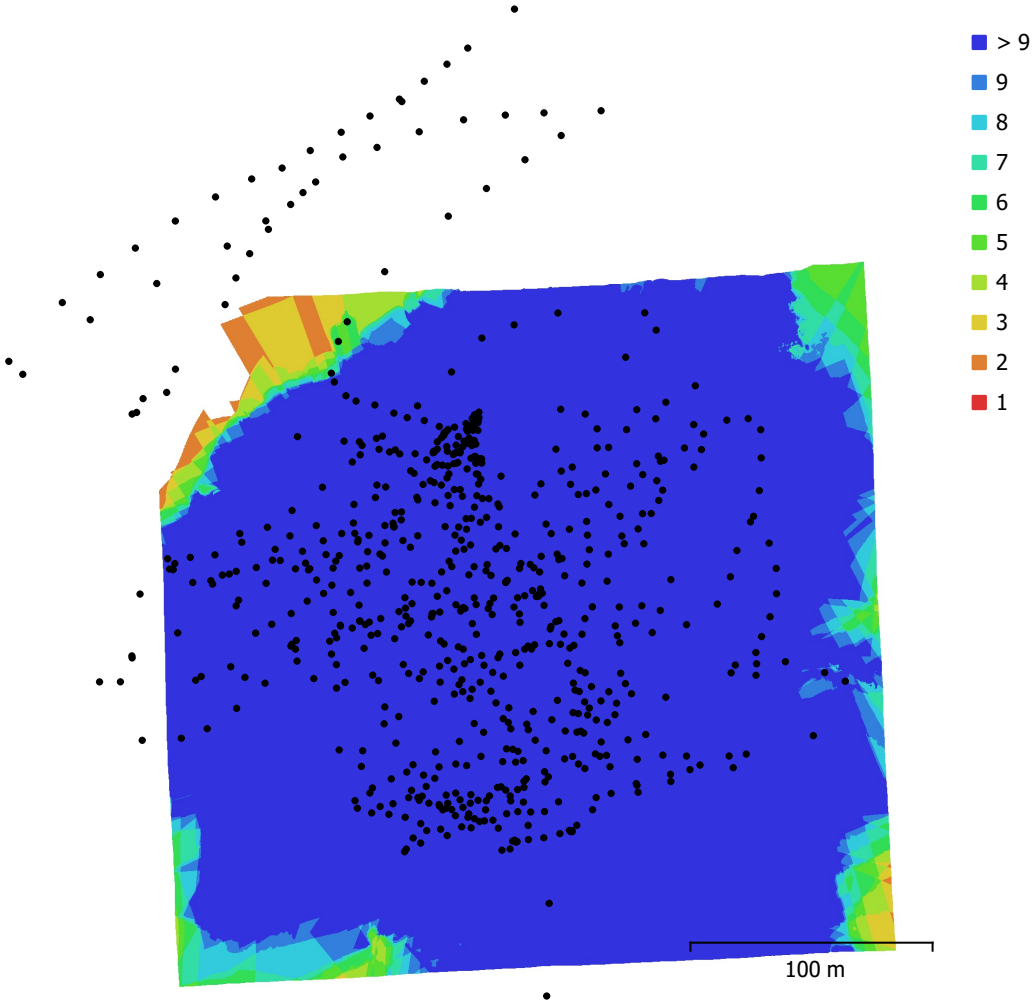

Fig. 1. Camera locations and image overlap.

Number of images:	700	Camera stations:	682
Flying altitude:	85.9 m	Tie points:	95,144
Ground resolution:	9.24 mm/pix	Projections:	662,913
Coverage area:	0.0812 km²	Reprojection error:	0.809 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
NIKON D7100 (35 mm)	6000 x 4000	35 mm	4.04 x 4.04 µm	No
NIKON D7100 (35 mm)	4000 x 6000	35 mm	4.04 x 4.04 µm	No

Table 1. Cameras.

Camera Calibration

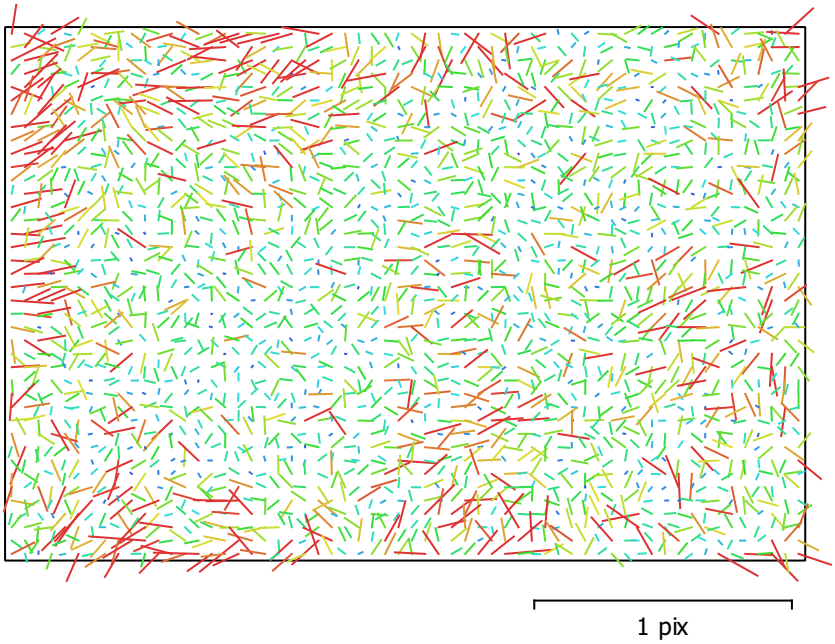

Fig. 2. Image residuals for NIKON D7100 (35 mm).

NIKON D7100 (35 mm)

667 images

Type	Resolution	Focal Length	Pixel Size
Frame	**6000 x 4000**	**35 mm**	**4.04 x 4.04 µm**

F:	9191.47		
Cx:	23.1251	B1:	-2.89408
Cy:	-68.4025	B2:	0.0885247
K1:	-0.186603	P1:	0.000198623
K2:	0.247548	P2:	-0.000290873
K3:	-0.21721	P3:	0
K4:	0	P4:	0

Camera Calibration

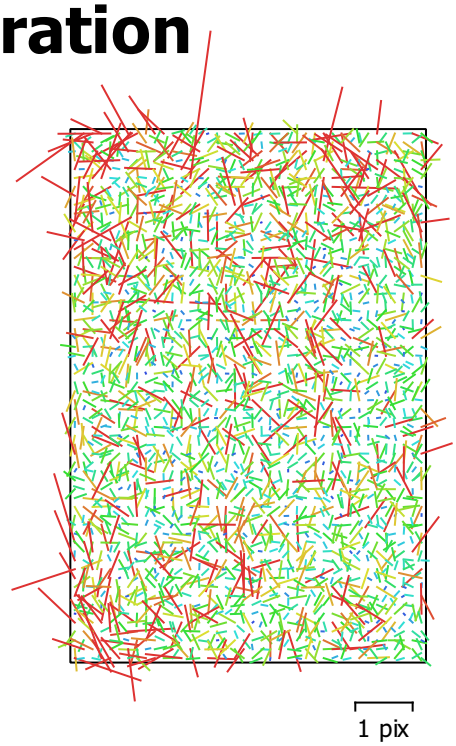

Fig. 3. Image residuals for NIKON D7100 (35 mm).

NIKON D7100 (35 mm)

33 images

Type	Resolution	Focal Length	Pixel Size
Frame	**4000 x 6000**	**35 mm**	**4.04 x 4.04 µm**

F:	9225.49		
Cx:	-24.0907	B1:	-0.164274
Cy:	-7.84417	B2:	-1.08068
K1:	-0.189036	P1:	-0.000370017
K2:	0.264827	P2:	-0.000191262
K3:	-0.234898	P3:	0
K4:	0	P4:	0

Camera Locations

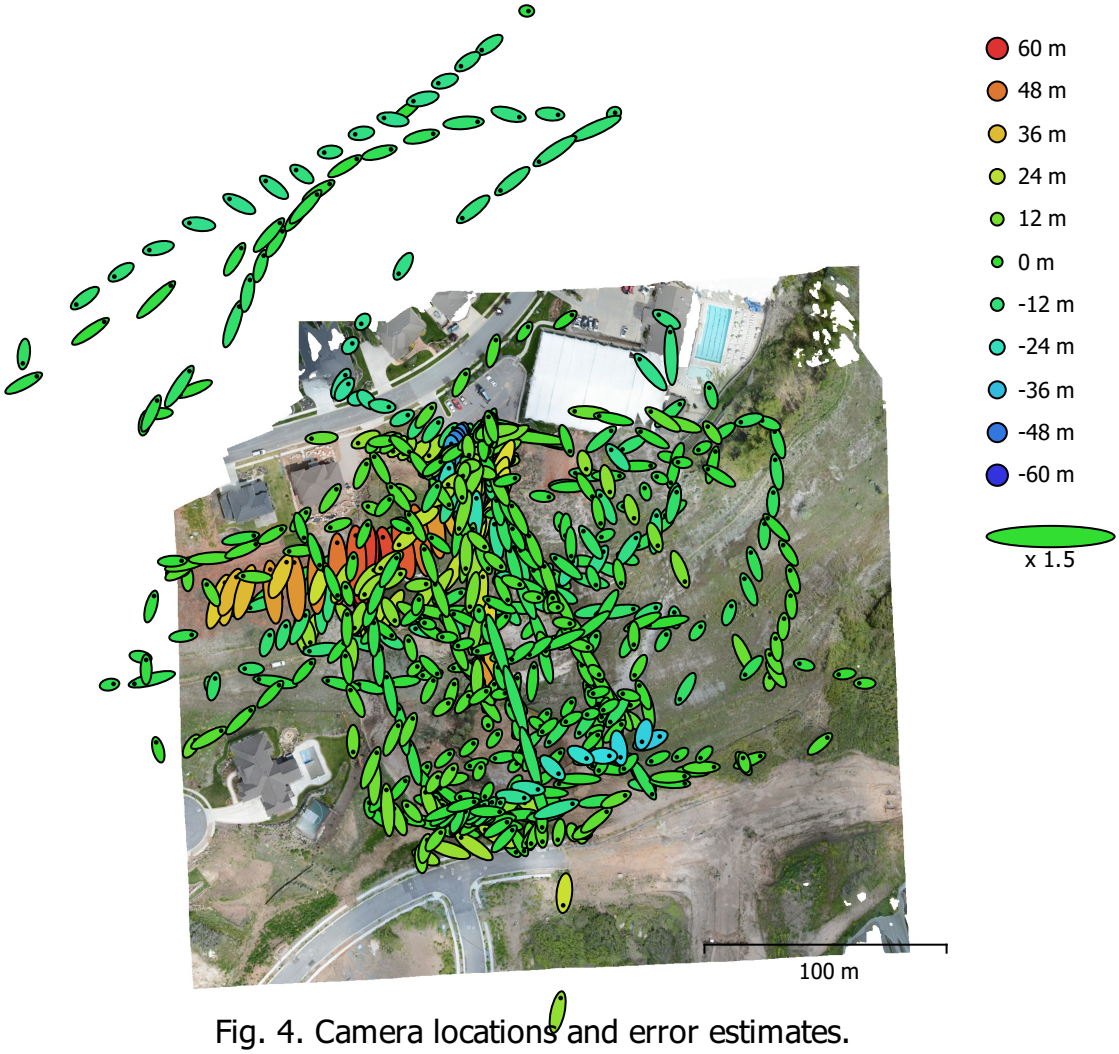

Fig. 4. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
4.07191	5.19351	13.4783	6.59947	15.0073

Table 2. Average camera location error.
X - Easting, Y - Northing, Z - Altitude.

Ground Control Points

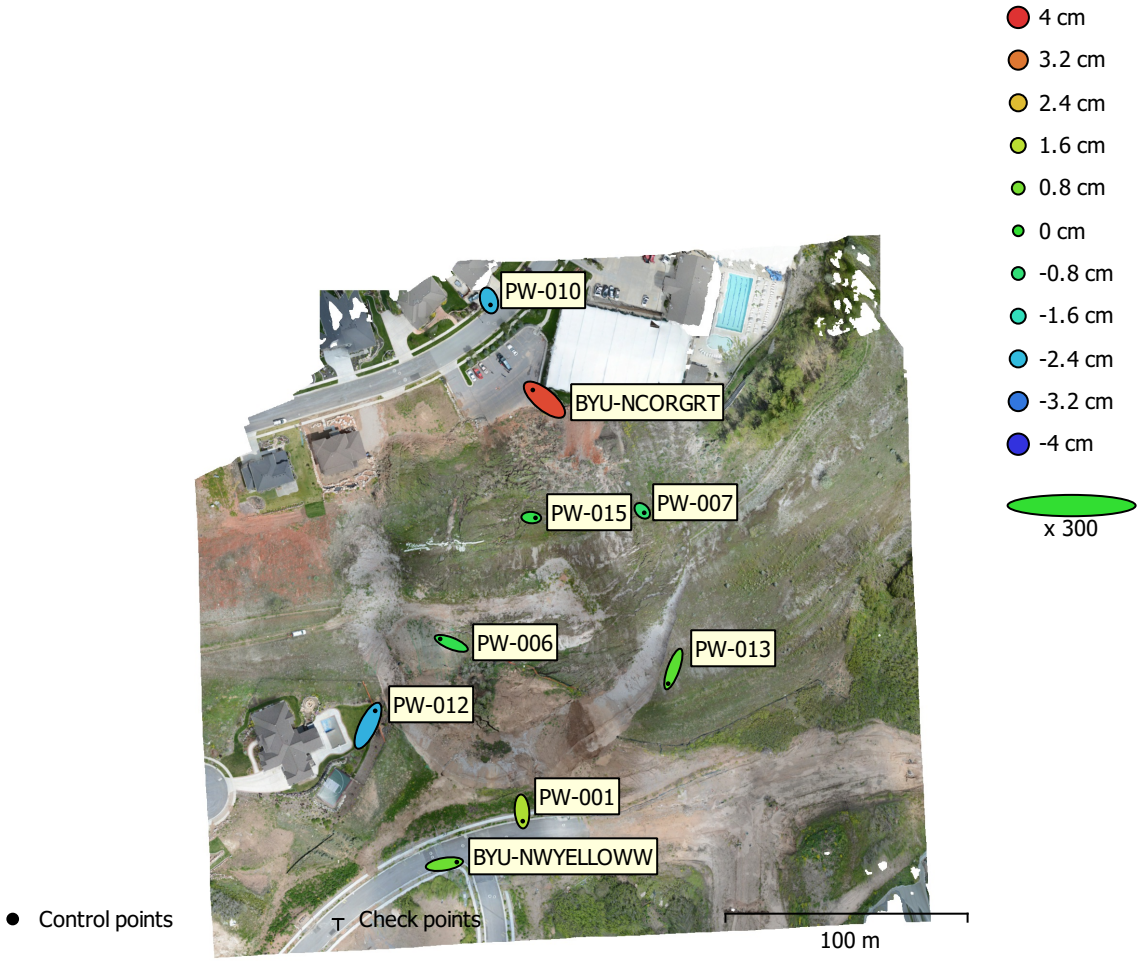

Fig. 5. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
9	2.08205	2.37736	1.82265	3.16019	3.64813

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)
BYU-NCORGRT	-3.1929	2.66804	3.73667	5.59247	0.133 (7)
BYU-NWYELLOWW	3.41809	0.552424	0.675789	3.52778	0.104 (3)
PW-001	0.197219	-2.6771	1.42996	3.04147	0.058 (5)
PW-006	-3.0515	1.21393	-0.319823	3.29963	0.082 (4)
PW-007	0.533662	-0.545751	-0.739262	1.06261	0.032 (4)
PW-010	0.401756	-1.22546	-2.46576	2.78265	0.098 (6)
PW-012	1.97901	4.09526	-2.53339	5.20631	0.469 (4)
PW-013	-1.44281	-4.0281	0.461663	4.30353	0.290 (5)
PW-015	1.15827	-0.0777519	-0.272711	1.19248	0.060 (3)
Total	**2.08205**	**2.37736**	**1.82265**	**3.64813**	**0.196**

Table 4. Control points.

X - Easting, Y - Northing, Z - Altitude.

Digital Elevation Model

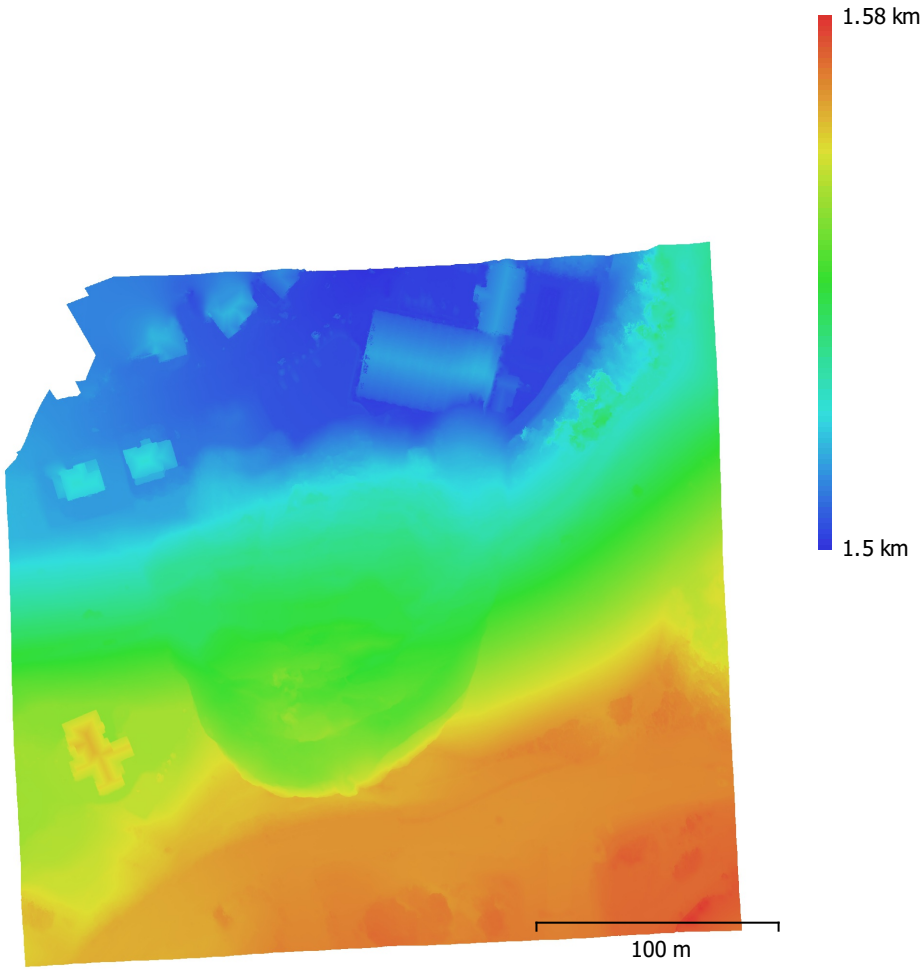

Fig. 6. Reconstructed digital elevation model.

Resolution:	3.7 cm/pix
Point density:	732 points/m²

Processing Parameters

General	
Cameras	700
Aligned cameras	682
Markers	9
Coordinate system	NAD83 / UTM zone 12N (EPSG::26912)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	95,144 of 138,877
Reprojection error	0.808949 (6.893 max)
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	10.5079
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	No
Key point limit	500,000,000
Tie point limit	1,000
Filter points by mask	No
Matching time	10 hours 8 minutes
Alignment time	14 minutes 20 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k3, p1, p2
Optimization time	1 minutes 4 seconds
Dense Point Cloud	
Points	69,753,269
Point colors	3 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Dense cloud generation parameters	
Processing time	20 hours 28 minutes
Model	
Faces	14,033,258
Vertices	7,017,933
Vertex colors	3 bands, uint8
Texture	14,096 x 14,096, 4 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Reconstruction parameters	
Surface type	Height field
Source data	Dense cloud
Interpolation	Enabled
Processing time	3 minutes 49 seconds
Texturing parameters	
Mapping mode	Adaptive orthophoto
Blending mode	Mosaic
Texture size	14,096
UV mapping time	3 minutes 46 seconds

General	
Blending time	4 hours 5 minutes
Tiled Model	
Texture	3 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Reconstruction parameters	
Source data	Dense cloud
Tile size	256
Face count	High
Enable ghosting filter	Yes
Processing time	11 hours 13 minutes
Software version	1.5.3.8469
DEM	
Size	8,536 x 8,560
Coordinate system	NAD83 / UTM zone 12N (EPSG::26912)
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	1 minutes 44 seconds
Software version	1.5.3.8469
Orthomosaic	
Size	32,959 x 32,403
Coordinate system	NAD83 / UTM zone 12N (EPSG::26912)
Colors	3 bands, uint8
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	32 minutes 39 seconds
Software version	1.5.3.8469
Software	
Version	1.5.5 build 9097
Platform	Windows 64