

Using UAV Technology to Map the Archaeology of the Little Springs Lava Flow in Mount Trumbull, Arizona

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Introduction and Background

The aim of this project was to use remote sensing techniques to address several spatial questions for CSULB Archaeologist Dr. Sachiko Sakai. An unmanned aerial vehicle (UAV) equipped with a digital camera was used to take aerial photographs of the study area and processed using PhotoScan (by AgiSoft) software to mosaic the images and produce an orthophoto that would be suitable for mapping the area.

The study area is on the southern lobe of the Little Springs lava flow and part of the Uinkaret Volcanic Field located in the Grand Canyon -Parashant National Monument, Northern Arizona. It is recorded as archaeological site AZ A:12:188 (ASM) aka "Lava Town" and contains remains of prehistoric structures on the top and at the base of the lava flow.

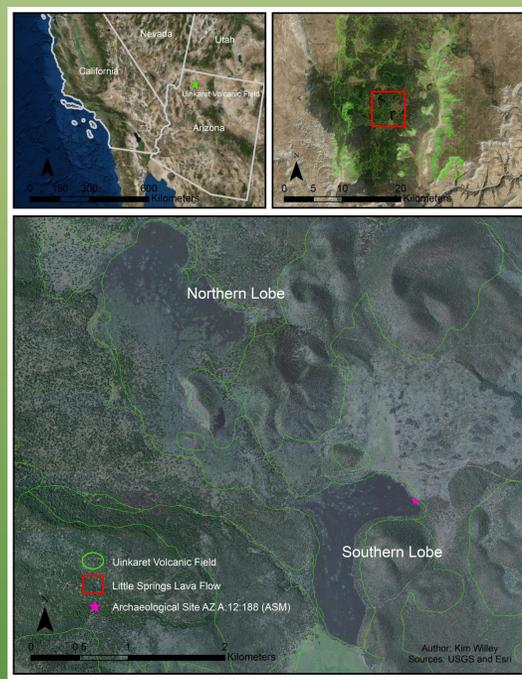


Figure 1. Overview of the Uinkaret Volcanic Field, Little Springs Lava Flow, and site AZ A:12:188 (ASM)

Data and Data Sources

UAV aerial photographs were the main data source with additional sources from the USGS, Esri, the Arizona State Museum (ASM), and Northern Arizona University graduate student Matthew Hintzman.

Dataset	Source
Aerial Photos	Personally collected in field
Uinkaret Volcanic Field Shapefile	United State Geological Survey (USGS)
Aerial Imagery Basemap	Esri
Hand Drawn Site Map #1	Arizona State Museum Archaeological Site Record
Hand Drawn Site Map #2	Matthew Hintzman MA thesis

Table 1. List of data and data sources used in the project

Methodology

All aerial photography was acquired in the field over a three week period from June 6 -24, 2014. A Mobius ActionCam set to five second time-lapse intervals was mounted onto a DJI Phantom 1 quadcopter. Five ground control points (GCPs) were established and UTM coordinates collected with a handheld Garmin GPS unit. All images were captured at a low altitude of approximately 100 feet.



Figure 2A, B and C. In the field downloading imagery, DJI Phantom 1 quadcopter, and Mobius ActionCam mini sports camera

PhotoScan extracts 3D data from aerial images by employing structure from motion (SfM) algorithms to reconstruct sparse point clouds from overlapping photographs. The basic PhotoScan workflow was followed after editing out poor quality images and experimenting with different parameters to ensure the best possible results. For example, the photos were aligned using high accuracy, the point cloud was optimized, and images containing unwanted imagery were masked.



Figure 3A, B and C. Example of overlapping aerial imagery. There were over 4000 images collected that needed sorting and editing

Basic PhotoScan workflow

- Add photos
- Align photos to build a point cloud model
- Build mesh to estimate the applicability of reconstruction
- Build model texture as an orthophoto
- Export orthophoto results

The final step was to then georeference the resulting orthophoto in ArcMap using the GCPs.



Figure 4. Spatial model depicting the project workflow

Timeline



Figure 5. This was the projected timeline for applied thesis project completion

Results

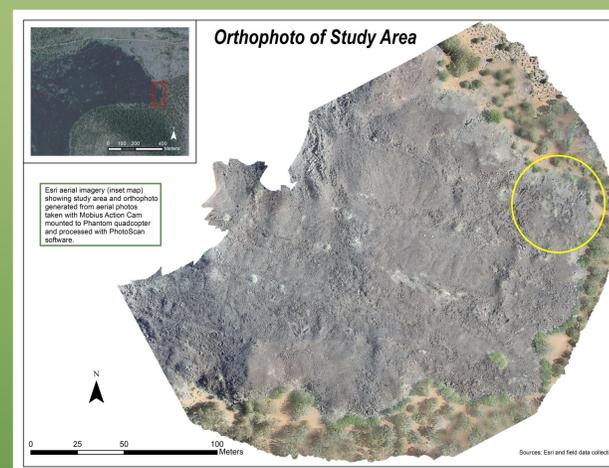


Figure 6. Orthophoto generated by PhotoScan from a mosaic of the aerial photos. Some of the structure remains on top of the flow (cluster of small circular shapes) are very visible as shown in the highlighted area of the main map

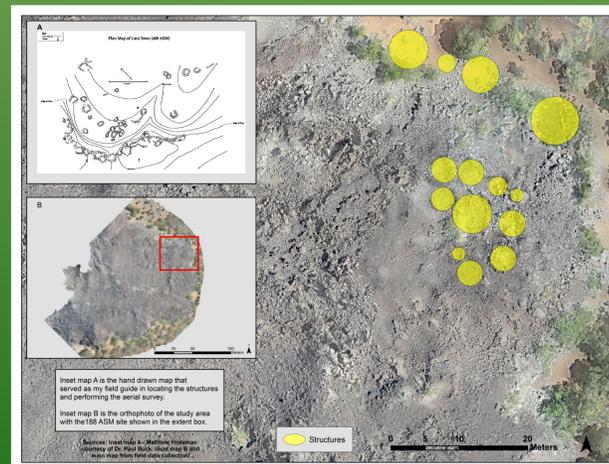


Figure 7. Some of the structures on top and at the base of the flow have been digitized in the main map as examples to better illustrate their locations. Inset map A is a copy of the hand-drawn map provided by Dr. Paul Buck of the Mount Trumbull Prehistory Project and was my only source for locating the structures in the field

Discussion

It was anticipated that the orthophoto would address the following spatial questions:

- Is it possible to distinguish the structures that are on the hand drawn map of 188 ASM?
- If so, is it possible to measure the size of the rooms?

Many of the structures both on the flow and at the base are visible in the orthophoto. This is significant because it provides us with a better much image of the site.

Unfortunately, there are also several significant errors in the results. The orthophoto was unable to be properly georeferenced using the UTM coordinates from the GCPs so the image is not to scale and unable to create a spatially accurate map. Therefore, it was not possible to address the second question and get accurate measurements of the rooms. The resolution is also relatively low and blurry in some areas when zoomed in.

The problems could possibly stem from a number of issues, none of which I'm sure are the cause of the errors. The Mobius has a slight fisheye lens and there may have been an inability in PhotoScan to fully correct for it or the photos need to be re-edited for even better quality for alignment when building the point cloud.

Conclusion

Overall, this project was able to deliver a decent orthophoto using the available resources and allow for a better overview of an archaeological site that did not have any low altitude aerial imagery available. Many of the structures are easily visible and upon closer inspection others are too.

This project is still considered a work in progress as I believe that a better quality orthophoto could still be generated. There were over 4000 images that were collected in the field and further editing and processing in PhotoScan will probably be able to yield better results.

Acknowledgements

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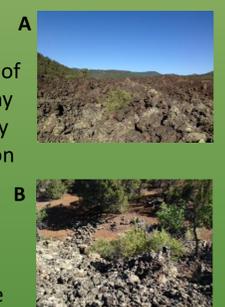


Figure 8A and B. View across the flow and looking down at the structures along the base