Photogrammetry at Lapa do Picareiro: Innovative Techniques for Recording Spatial Information at a Paleolithic Site

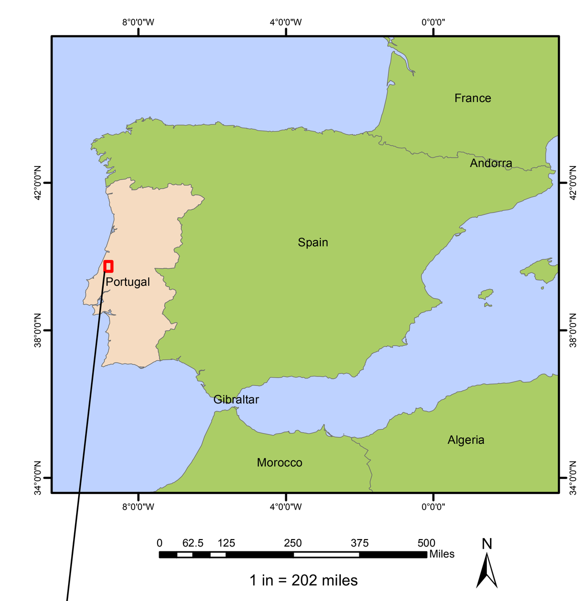
Brandon Zinsious and Jonathan Haws

ABSTRACT

Archaeology as a practice is destructive. Once an area of interest has been excavated, any information that has not been recorded is lost. Many dating methods also require the destruction of the sample to obtain results. Until recently, information obtained from digital piece proveniencing systems, drawings, and pictures have made up the spatial record. With the development of photogrammetric techniques, recording spatial data has become more accurate, faster, and more efficient than previous methods used in Archaeology. This poster shows the results of photogrammetric work done in the field at Lapa do Picareiro. This Middle and Late Paleolithic site offers the unique opportunity to apply photogrammetric techniques to archaeological subjects inside of a cave with depositions dating to the transition from Neanderthals to Anatomically Modern Humans. Photogrammetry was applied to the site in order to provide annual spatial information for artifact context and tracking site change. This poster shows the results of three dimensional models of not only cave surfaces, rock layers, and geological stratigraphy, but also of faunal remains destroyed for isotope analysis. The end result, beyond digitally recording spatial information, is the recreation of artifacts and space with the use of another recent technological development: three dimensional printing.

BACKGROUND

Lapa de Picareiro is a Middle and Late Paleolithic archaeological site located in a cave in central Portugal. The cave, which sits atop a mountain accessible only by goat trail, presents a unique set of problems for recording archaeological site context. These problems include, but are not limited to, accurately recording space in low light conditions, getting heavy spatial technology equipment up to the cave and back down, and being able to integrate the spatial information digitally into a predetermined local coordinate system. Piece proveniencing, LiDAR, and photographs, and drawings have all been used to try to solve these problems, but each fall short in some way. Photogrammetry was introduced into the excavation as another form of recording space. This poster shows the results of the work done in the 2015 summer field season applying photogrammetry to these problems.



Lapa de Picareiro. Facing the mouth of the cave (south). Image obtained using UAS technology.

MATERIALS

In the field, photogrammetry requires a camera to take photographs, markers to identify control points, and a total station to record the markers x, y, and z coordinates in the local grid. All of this equipment was already present for other purposes in the excavation so no extra material was needed. In the field, pictures were taken in a dome pattern around the area of interest until all viewpoints were recorded. Post-collection work requires a photogrammetric program. For our desired results, we used Agisoft Photoscan.

RESULTS

Fig. A

Models were created for multiple different aspects of the cave in 2015. A previously closed off room was excavated in the back of the cave during the 2015 field season and a model was created to provide context to the piece proveniencing carried out in the area. This model, which can be fully manipulated which a computer, is shown as three figures on this poster; The top view (Fig. A), the front view (Fig. C) and a view from the front rotated 45 degrees to cave east (Fig. D). An image created to give spatial context to material remians in the back room was creted using the a model and piece plots from the total station (Fig. B). The black dots are material from Layer "O" hearths. The green dots are material collected from Layer "T" hearths. Another model was created for a layer of large clasts which makes up the geologic Layer "T". An image of this model in Agisoft with its bounding box (Fig. E) can be seen above a finished model of the area facing cave east (Fig. F).

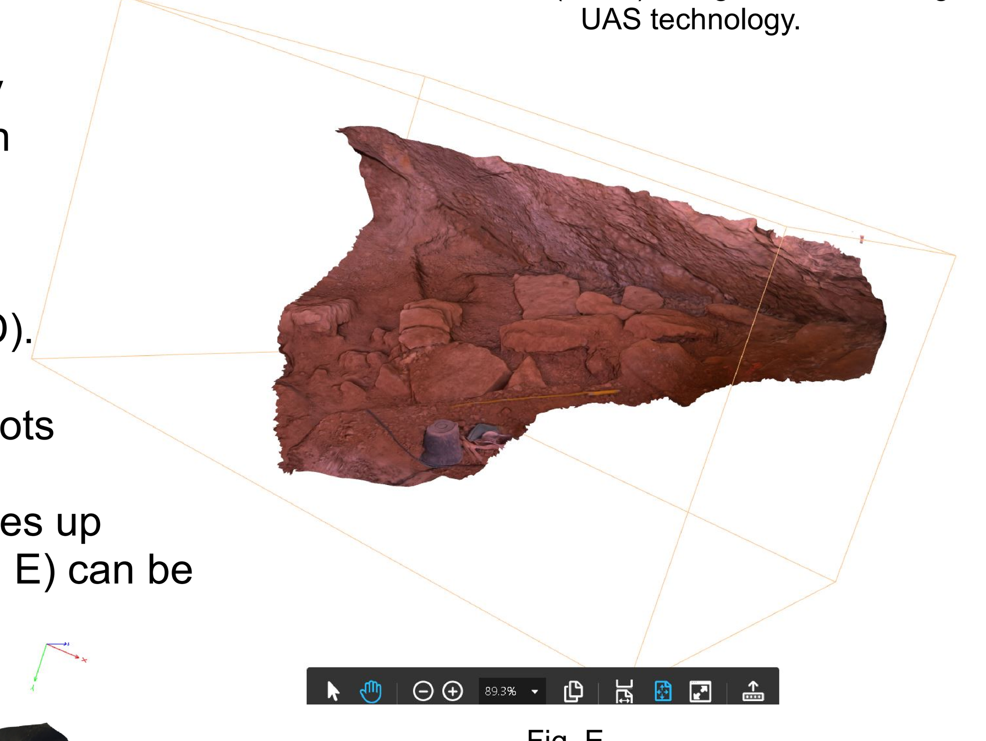


Fig. E

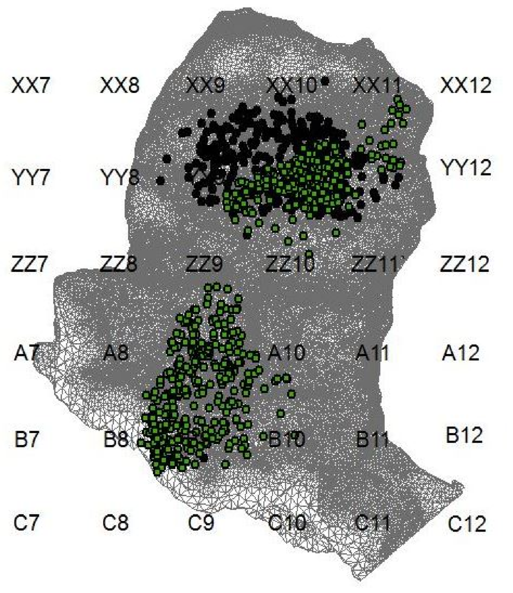


Fig. B

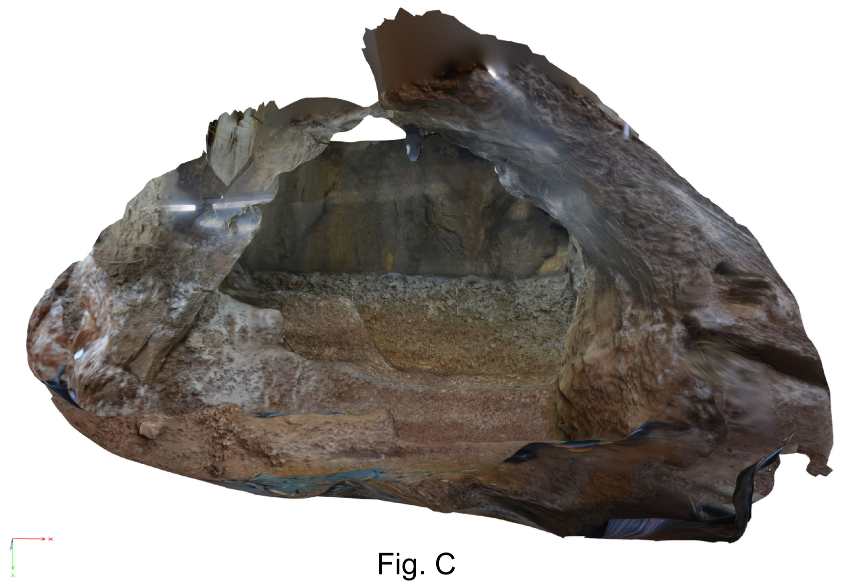


Fig. C

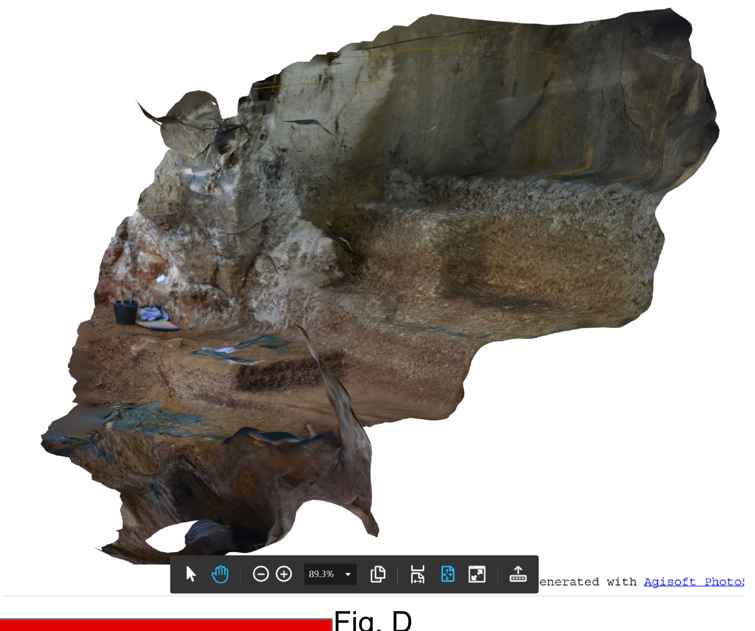


Fig. D

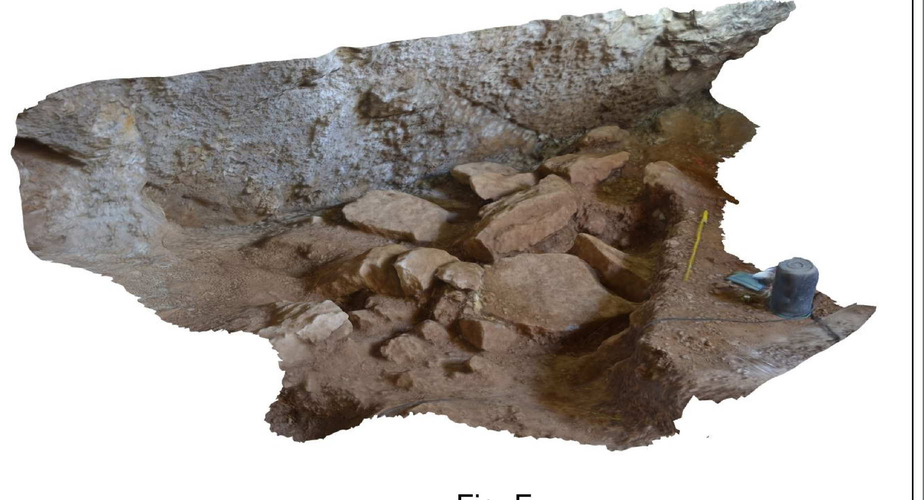
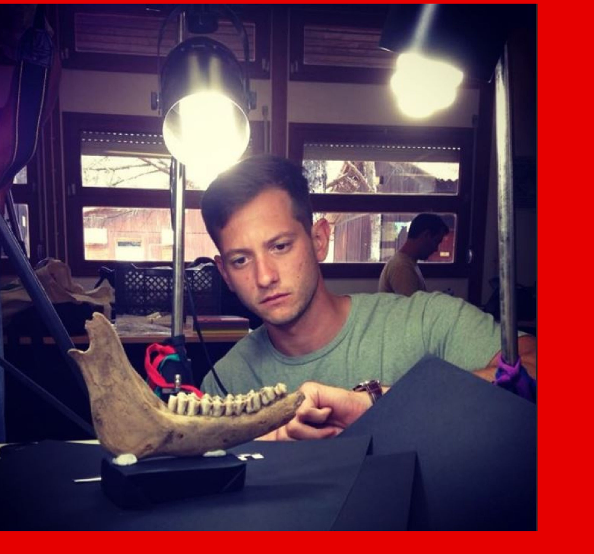


Fig. F

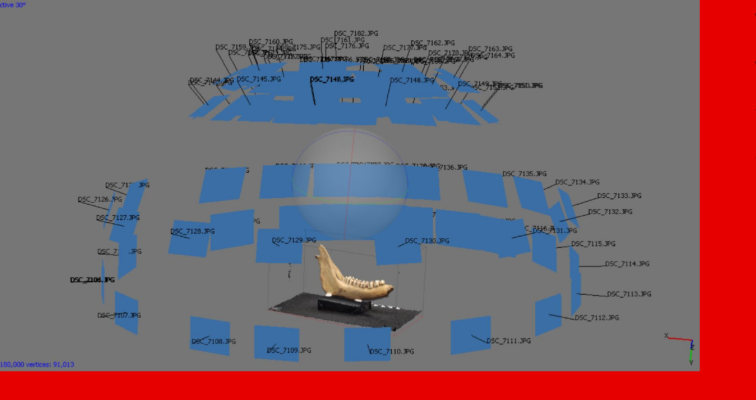
DISCUSSION

The 2015 field season produced multiple models. It was the first year photogrammetry was used and as such acted as an experimental year for the technology at the site. Low lighting effected the model clarity as well as a lack of suitable control points. Although usable, the models produced are all low resolution. The work done for 2015 has been invaluable for setting up the large photogrammetric work to be done in the 2016 season. Annual Photogrammetric work will be done on the entire site to compare to future annual LiDAR scans. The end goal will be to compare accuracy and resolution between the two methods of recording space.

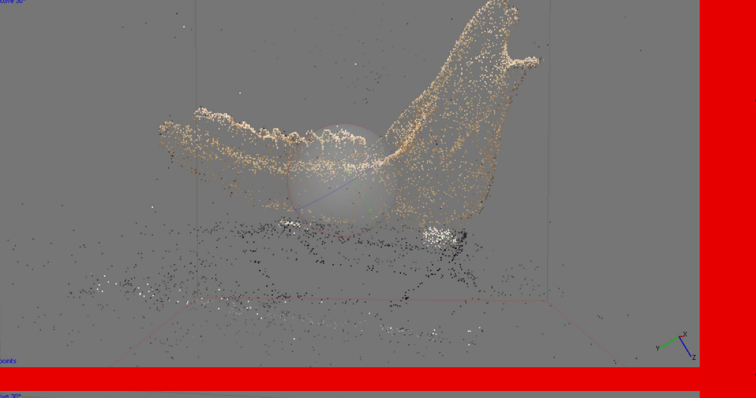
From Physical to Digital and Back Again: A Mandible's Journey



After choosing your subject or area, set up lighting in such a way that shadows being cast on the object is minimal. Contrast is necessary for the software so be sure to adequately light the object without saturating it with light.

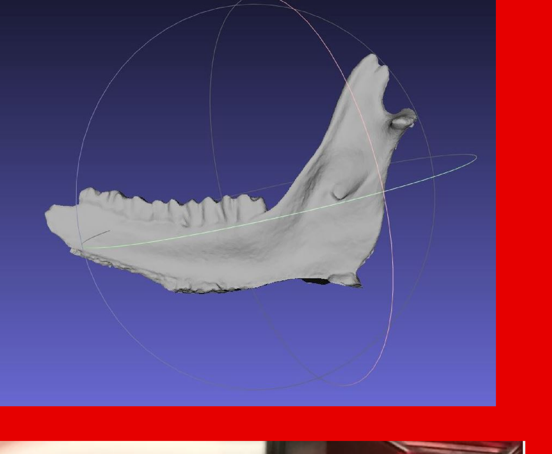


Take pictures of the object, moving around the object in a circular fashion. Each pictures field of view should overlap between thirty and sixty percent. Start parallel with the surface the object is resting on. Then raise your camera in fifteen degree intervals until you have coverage of the object that would resemble a dome. In this image, the blue rectangles represent the camera positions.

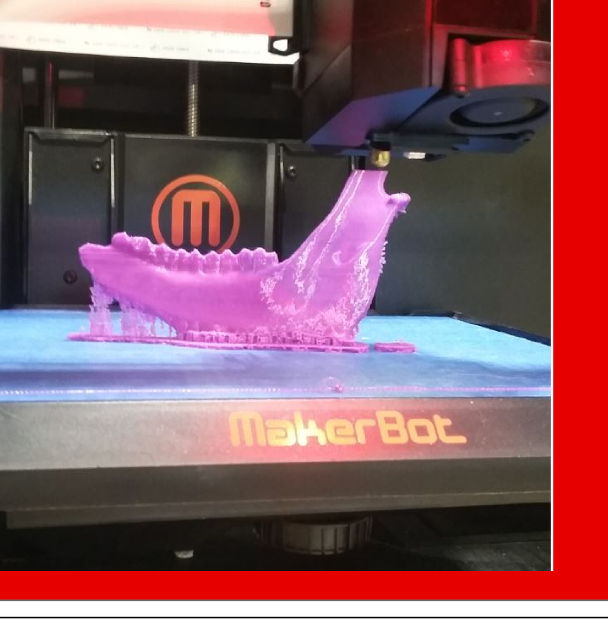


Upload the pictures into Agisoft Photo Scan. Align the photos, which allows the software to find common points among the group of pictures. This is why picture overlap in the field is important.

Once common points are found using changes in geometry, proceed through the Agisoft workflow by editing erroneous points and creating a dense point cloud, surface mesh, and texture. Make sure your bounding box is set to place your model in space along the axis needed for whatever coordinate system you are working in. Add control points to allow the integration of the model into various systems. Once your model is complete, export the file as a .STl. This is a STereoLithography file, used for three dimensional information.



Open a mesh software like MeshLab. Import your .STL. Edit the model by cropping unwanted areas or erroneous surface points. This is your last chance to edit the model surface before 3D printing. This stage can also include AutoCAD or other three dimensional editing soft wares. We use Autodesk 3Ds to create landscape models. Save the file as a new .STL.



Open your .STL into the proprietary software used by the 3D printer of your choice. I used MakerBot as it was available and intuitive to use. Orient the bounding box to fit your build plate and print. Enjoy watching your model appear in the physical world. Compare to your original if you can.

Maps, Photographs, and Models created by Brandon Zinsious

Base Layer for Location Map from NaturalEarth GIS Data

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