

3D Modelling

Processing to Create a 3D Model

These guidance notes take you through how to process multiple photographs of a rock art panel to create a 3D model. In order to do this, you first need to capture the right sort of rock art images - please see our **3D modelling in the Field** guidance for further information.

You will be processing your photographs in a Standard Version of **Agisoft PhotoScan**. This is a fairly intuitive software and the main commands are stored in the taskbar 'Workflow' menu (shown in the screen shot below), making it easy to follow the necessary basic steps.

Please note that the Photoscan software is being continually updated, and there may be slight variations between your version of the software and the guidance detailed below.

What you will need:

- ① **Your field photographs:**

These are the images that you (or a member of your team) captured during 3D recording in the field. You should download these into one file, named with the panel name (and number, if relevant) of the rock you recorded.

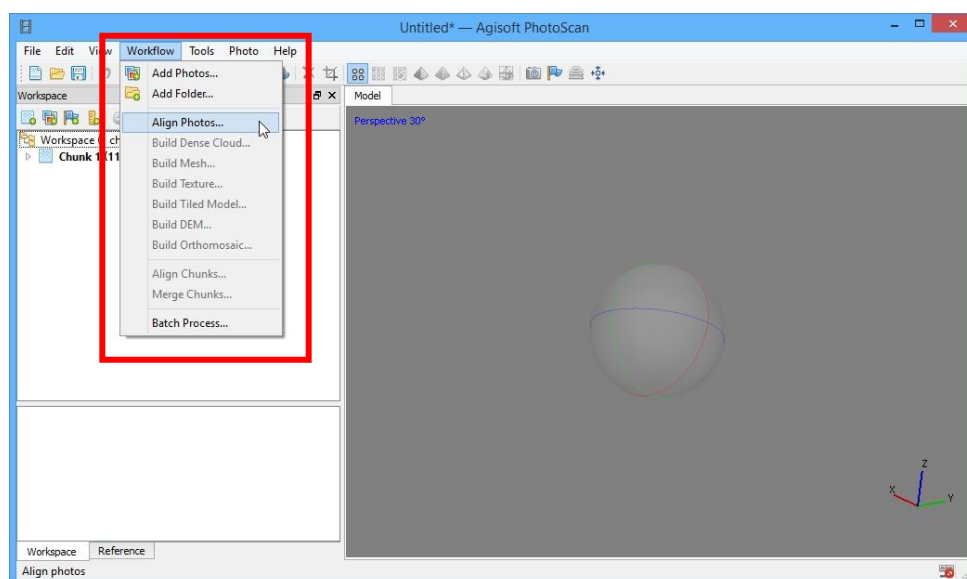
- ② **Processing software:**

Agisoft Photoscan is the best one to use for our purposes. This software requires a licence, and we will provide at least one licence for each ScRAP Team that wants to create 3D models from their photographs. Other free softwares are available, and some are listed at the end of this guidance.

- ③ **Software for presenting the models:**

There are various forms of software that can be downloaded free from the internet. We recommend **Meshlab** for enhancing and visualizing the models. We also recommend that you share your models by uploading them to the on-line platform, **Sketchfab**.

Each stage of 3D processing using Agisoft Photoscan is set out below in numbered steps.



STEP 1: Download your Photographs (if not already done)

Download the photographs from your camera and save them in a specific folder named with the panel name/number. You will use this folder for all the files connected with the model for this particular panel. For consistency, it would be best to have a separate folder for each rock art panel that you process, and to name the folder with the panel name and number.

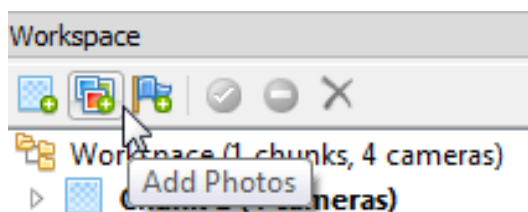
NOTE 1

It is good practice to save all the stages of your processing in individual files so that you or other people can return to them if needed. For example:

- ◎ *Drumtroddan1_aligned*
- ◎ *Drumtroddan1_dense.cloud*
- ◎ *Drumtroddan1_mesh*
- ◎ *Drumtroddan1_texture*

STEP 2: Add Photos

Use the 'Add Photos' button on the top of the Workspace pane, through the menu option in the 'Workflow' menu, or by right-clicking in the Photos pane.



NOTE 2

You will be able to see the individual photos that have been added to the project in the bottom window of the software. At this stage you can scan through all the images and delete the ones that are out of focus, too much light/shadow contrast, or have captured things like rucksacks or feet by mistake. Simply select the photograph in question with the mouse, right-click on it and select 'Remove'.

STEP 3: Align Photos and create a Sparse Point Cloud

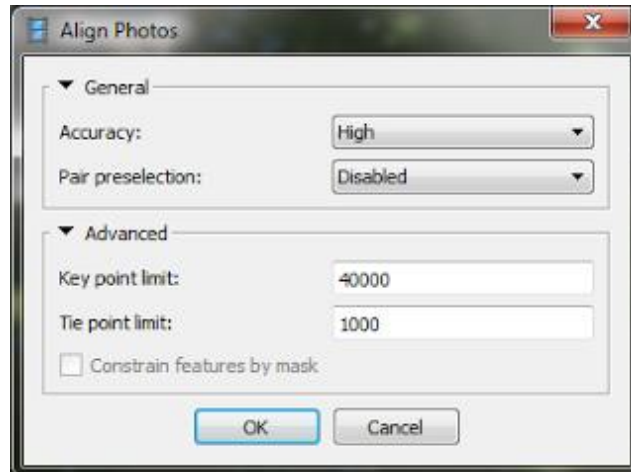
This step generates the initial alignment parameters for the photos and a Sparse Point Cloud.

When selecting this option, a pop-up window will appear with a few options. Whenever possible, keep *Accuracy* in 'High' (or 'Medium' if your computer is not very powerful, as this will take less time to process), since it is important that the stitching of the photographs is done rigorously. This step can take some time, but it is the most important stage of the process.

Settings

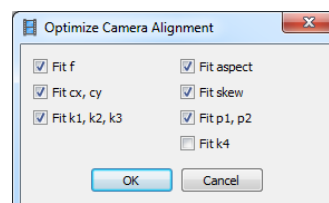
- On the top menu bar: Workflow > Align Photos
- Alignment parameters:
 - Accuracy:
 - High: is best for smaller numbers of photos
 - Medium: is best for larger numbers of photos
 - Pair Selection: Keep the option 'Disabled' as it works for most datasets.
 - Advanced:
 - Key Point Limit: 40,000 is default. Smaller numbers of key points can speed up processing, but you run the risk of not having enough points to align photos. In general, you **do not need** to change these settings.

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Optional step

In order to improve the quality of your model, you may want to optimize the alignment of the cameras by selecting the optimization icon that looks like a wizard's wand (on the left). Photoscan will now show you a window that lists a lot of parameters you can select. Simply select them all but the last and click OK.



The result should be an improved sparse cloud – see below.

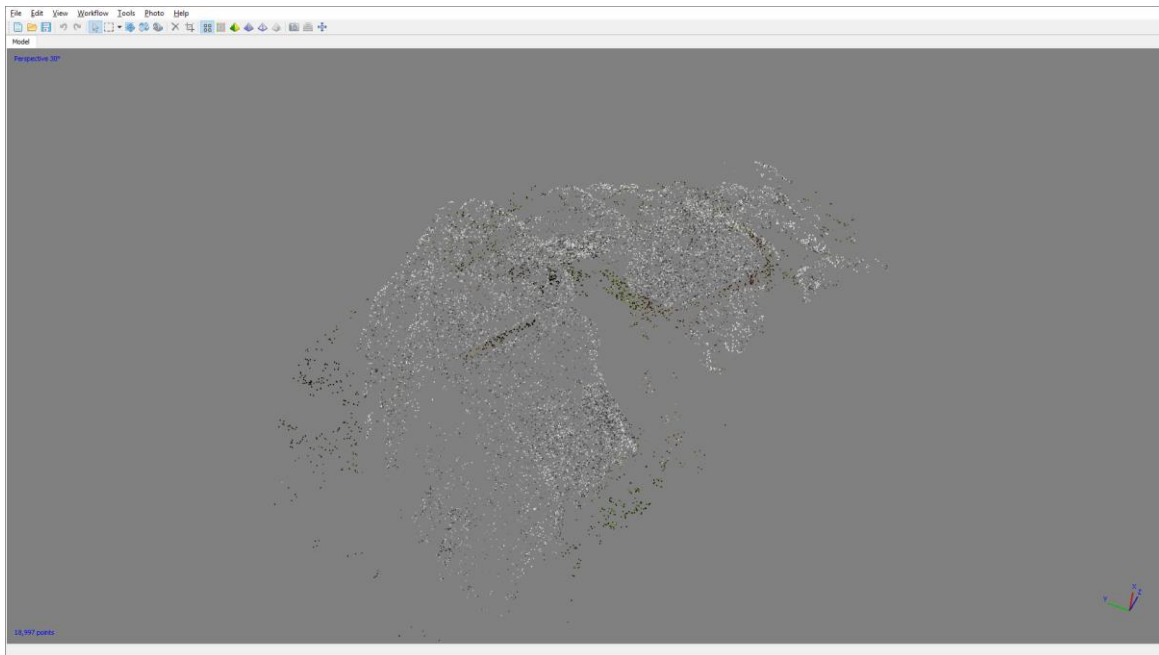


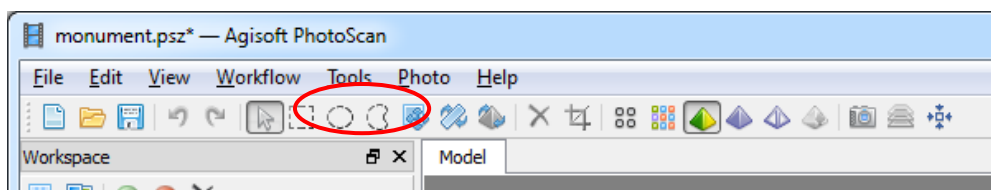
FIGURE 1. Example of a Sparse Cloud from Alan Thompson's (NOSAS) model of Cnoc Bhiosta. This originates from the initial process of stitching the various photographs together. The points compose an unevenly distributed sparse point cloud.

NOTE 3

If your Sparse Cloud turns out to be very large, you can cut it down a little bit by trimming the amount of ground (for example) that you have captured. If you prefer, you could trim your model at the next stage (Dense Cloud) instead.

Use a selection tool (on the taskbar) to define which areas you would like to cut. The option on the right of the selection toolkit is a free-hand solution that allows you to cut the unnecessary sections of the model by delimiting (for example) just the edges of the panel. Once selected, a pink area will appear. Press delete on your keyboard.

Note that there is an 'invert selection' option under Edit which is very useful. You can use this to select the bits you do not want to remove, then invert and delete them.



STEP 4: Build the Dense Cloud

After finishing the processing of the Sparse Cloud, the next stage is to build the Dense Cloud. To do this, chose the next option on the 'Workflow' dropdown menu: **Build Dense Cloud**.

At this stage you can select the resolution of the cloud. The majority of the models should be built on 'High' to 'Medium' resolution, unless the size of the cloud is too large to work with. This step can take some time, depending on the size of the project.

Once you have set the software running, this is a good time to go and have a cup of tea or, if necessary, leave the programme running overnight as it can take a considerable time, especially if your computer is not particularly high powered.

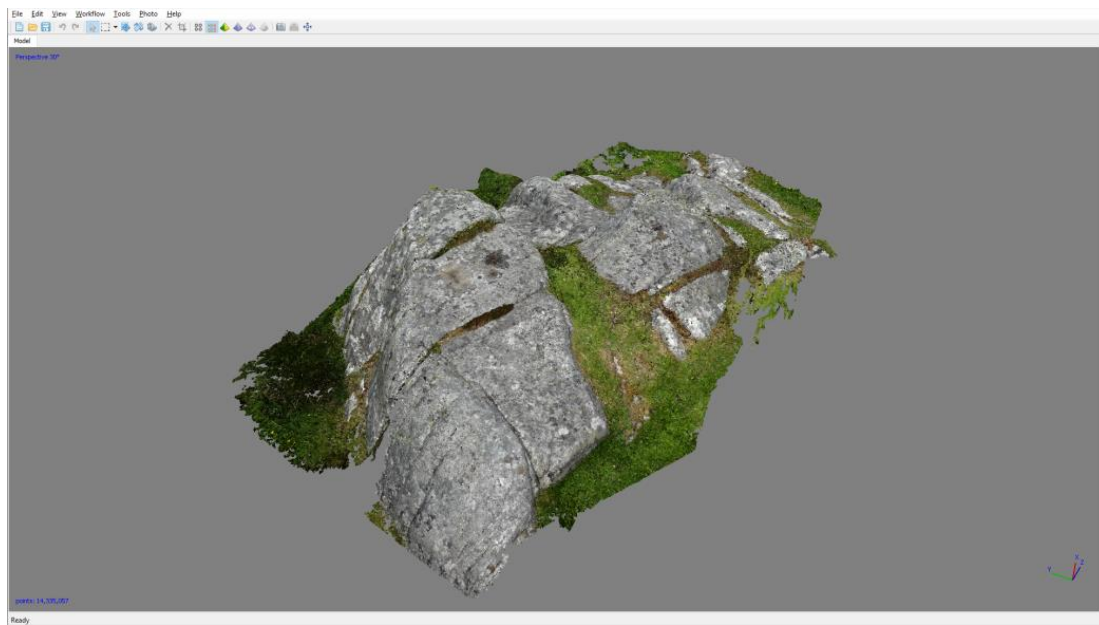
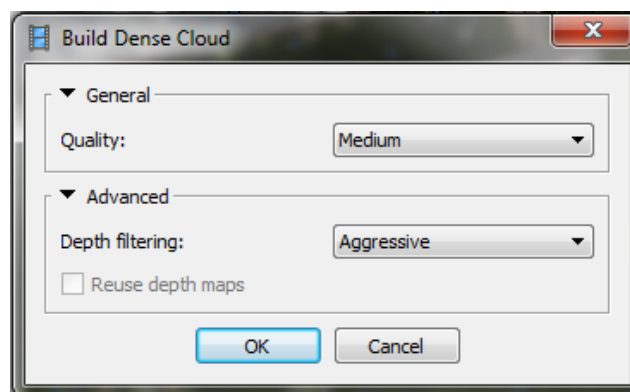


FIGURE 2. The Dense Cloud of the previous project. With the camera positions known, this fills in and details the Sparse Cloud, giving it a three-dimensional character.

Settings

On the top menu bar: Workflow > Dense Cloud

1. General:

- *Quality:*
 - Ultra High: Very intense processing option. Will probably crash your computer. Please avoid this option.
 - **High: great for smaller numbers of photos**
 - **Medium: good for larger numbers of photos**
 - Lowest, Low: produce low quality results (not usually the goal). Please avoid this option.

2. Advanced:

- *Depth Filtering:* Aggressive (default), limits points that are too far from the surface.
Use this option.

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STEP 5: Build the Mesh

The next stage is to build the geometric **mesh** for your model. This is the next step on your Workflow menu.

Settings

On the top menu bar: Workflow > Build Mesh. You will then be presented with a series of options. We recommend that you select the following:

1. General:

- *Surface Type:*
 - Height Field: only builds a mesh surface orthogonal to the reference system Z-axis (i.e. no undercuts will be modelled). This is the fastest mesh procedure and excellent if DEM¹s are going to be your final product. **Do not use this option**
 - **Arbitrary:** Will model every nook and cranny of the object. Best for oblique imagery, when point clouds or complex mesh surfaces are going to be the final product. **Use this option.**
- *Source Data:*
 - **Dense cloud:** **Use this option.**
 - Sparse cloud: **Do not use this option**

○ *Face Count:*

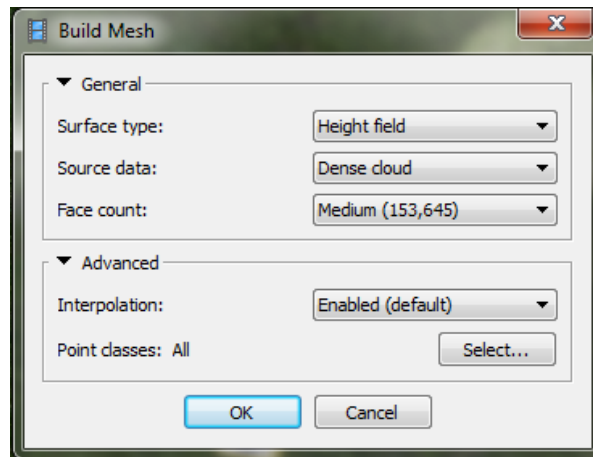
This refers to the number of polygons that the model will be decimated to after processing.

- **High:** **Use this option,** or
- **Medium:** **Use this option**
- Low: **Do not use this option**
- Custom: **Do not use this option**

¹ Digital Elevation Models of the terrain.

2. Advanced:

- **Interpolation**
 - **Enabled:** default, will interpolate over small holes in the surface. Use this option.
 - **Disabled:** no interpolation will be done
 - **Extrapolation:** will interpolate the surface and then extrapolate out to fill the bounding box.
- **Point Classes:** Use Default Option



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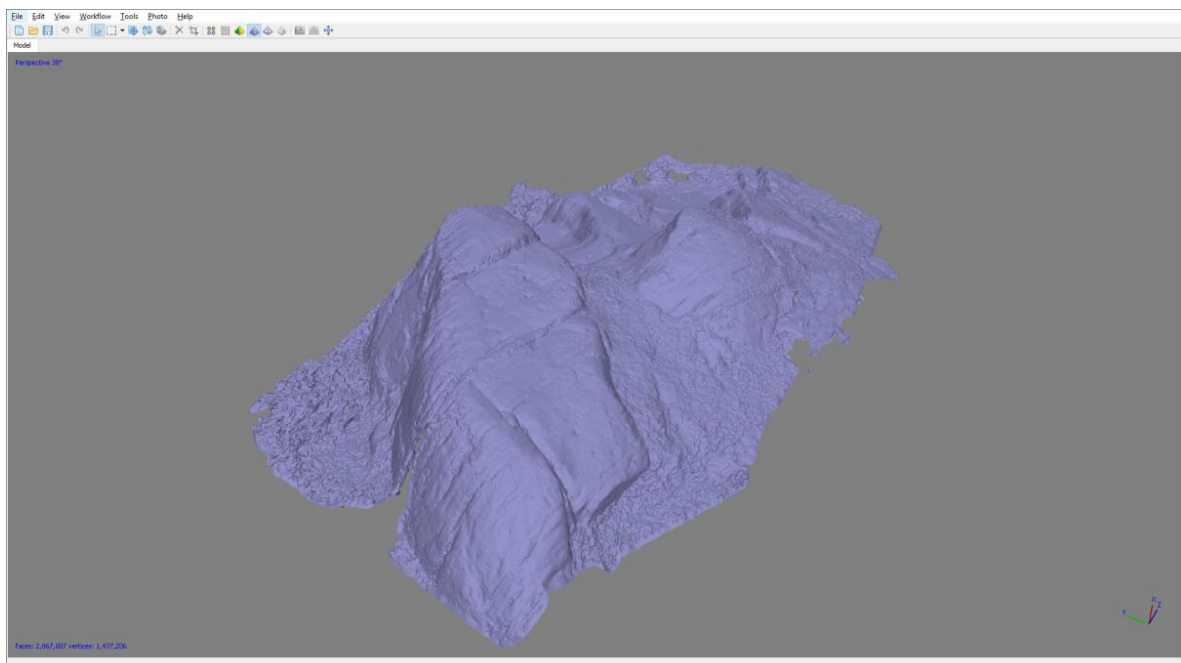


FIGURE 3. The Mesh resulting from the previous Dense Cloud of Cnoc Bhiosta, by Alan Thompson (NOSAS). A mesh is a collection of vertices (points), edges (straight line segments) and faces describing a 3D object.

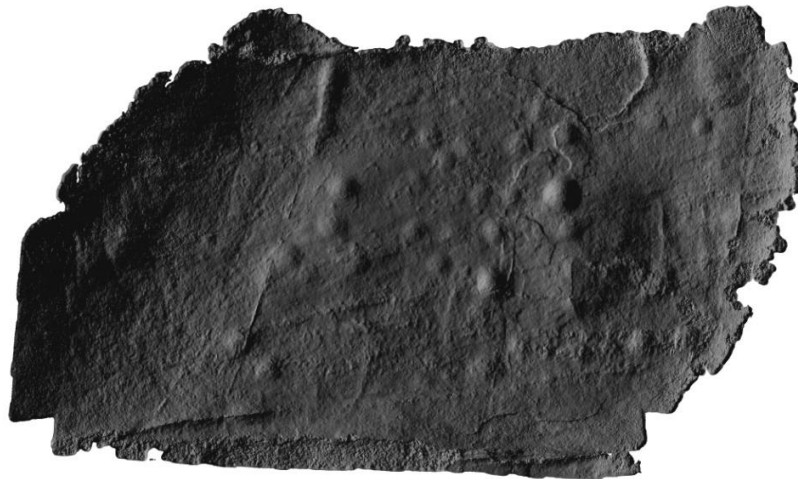


FIGURE 4. A detail of the 3D Model of Cnoc Bhiosta 1 made by Alan Thompson (NOSAS).

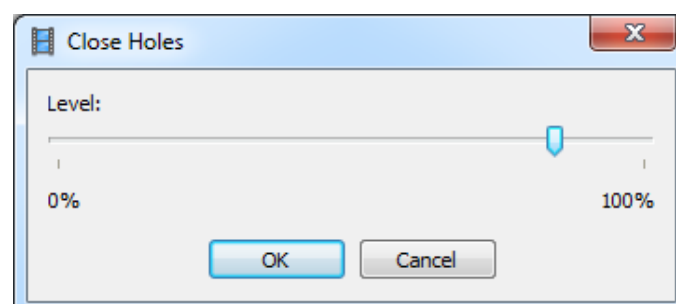
NOTE 4

1. **Decimating your model (Reducing the Model size)**

*If your Model is very large, and your computer does not have a huge memory, it may struggle. You can reduce the model size by **Decimating the Mesh** in Agisoft Photoscan. First, select **Tools>Mesh>Decimate Mesh** on the task bar. You can then chose the number of 'faces' you want to use. We recommend **500,000-7000,000 faces**, which should give you a model of around 50Mb. You can decimate your model at any stage.*

2. **Creating a pdf:** *If you wish to export your model as a PDF (see our guidance **Enhancing and Sharing your 3D Model**), we recommend that you reduce the number of faces to 200,000 (or more), then click OK.*

3. **Closing holes:** *If the Mesh was built without interpolation (and has holes in it!) you may need to close the holes at a final stage (although this is usually not necessary). In the **Tools** menu you will find the command **Close Holes**. In this dialog box, select the size of the largest hole to be closed (in percentage of the total model size). Click OK to start the holes closing procedure.*



STEP 6: Build Texture

The last option of the Workflow menu is to create the texture of the model. This step is really only necessary if you are exporting the 3D model (e.g. as .obj) and importing it into a 3D graphics software (e.g. MeshLab) (see our guidance notes *Enhancing and Sharing your 3D Model*). There are many possible options to build a texture, but we recommend the following:

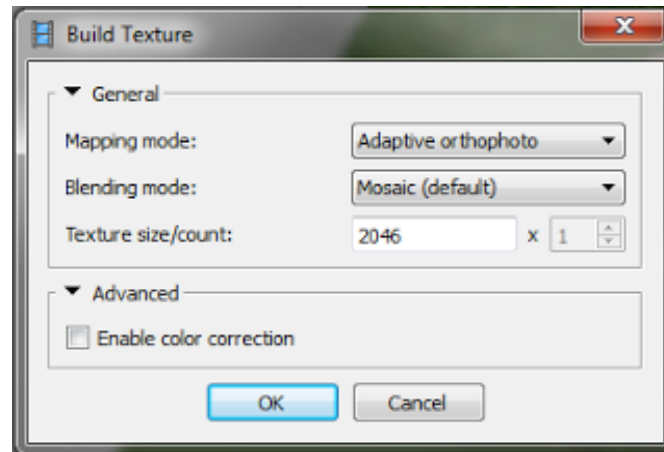


FIGURE 5. Visualization of a 3D model of a carved rock from Clava with texture, made by Alan Thompson (NOSAS).

Settings:

On the top menu bar: Workflow > Build Texture

- Keep the options offered by default → Press OK

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NOTE 5

If you have decimated your Mesh/Model (see **Note 4**), you will need to re-process the texture in order to have a matching image for the current number of faces of your model, before exporting it as PDF, OBJ or uploading it into Sketchfab.

References: <http://www.agisoft.com/support/tutorials/beginner-level/>
<http://www.agisoft.com/downloads/user-manuals/>

Summary

When you have processed your 3D model using the steps above, you should have the following files saved in your folder for that panel:

What	File Type	Minimum / Maximum size for each file
Photogrammetry field photographs	JPG	Recommended: 3 Mb /10Mb
Model created in Agisoft Photoscan	PSZ	No limits

Next Steps

Please now see our guidance ***Enhancing and Sharing your 3D Model*** for information on how to enhance your 3D model, share it with us, and make it publicly accessible on the internet.

3D modelling software

We would like all 3D models that you upload to our database to be created in **Agisoft Photoscan**. Following training, we will provide Agisoft Photoscan licences to specific people in each Community Team.

You can try out the Photoscan software by downloading a 30-day free trial version from the Agisoft website: <http://www.agisoft.com/>.

If you would like to experiment with other types of 3D modelling software, there are various options freely available on-line, including:

Regard3D: <http://www.regard3d.org/>

VisualSFM: <http://ccwu.me/vsfm/>

3DFlow: <https://www.3dflow.net/3df-zephyr-free/>

Autodesk 123DCatch: <https://autodesk-123d-catch.en.softonic.com/?ex=DSK-309.0>.

For more information, see: <https://pfalkingham.wordpress.com/2016/09/14/trying-all-the-free-photogrammetry/>

Free ways to manipulate and share your 3D model

Meshlab: <http://www.meshlab.net/>

Sketchfab: <https://sketchfab.com/>

If you are interested in being creative with your 3D model on Sketchfab, you might like to look at: <https://www.digitaltrends.com/cool-tech/sketchfab-3d-remix-challenge/>