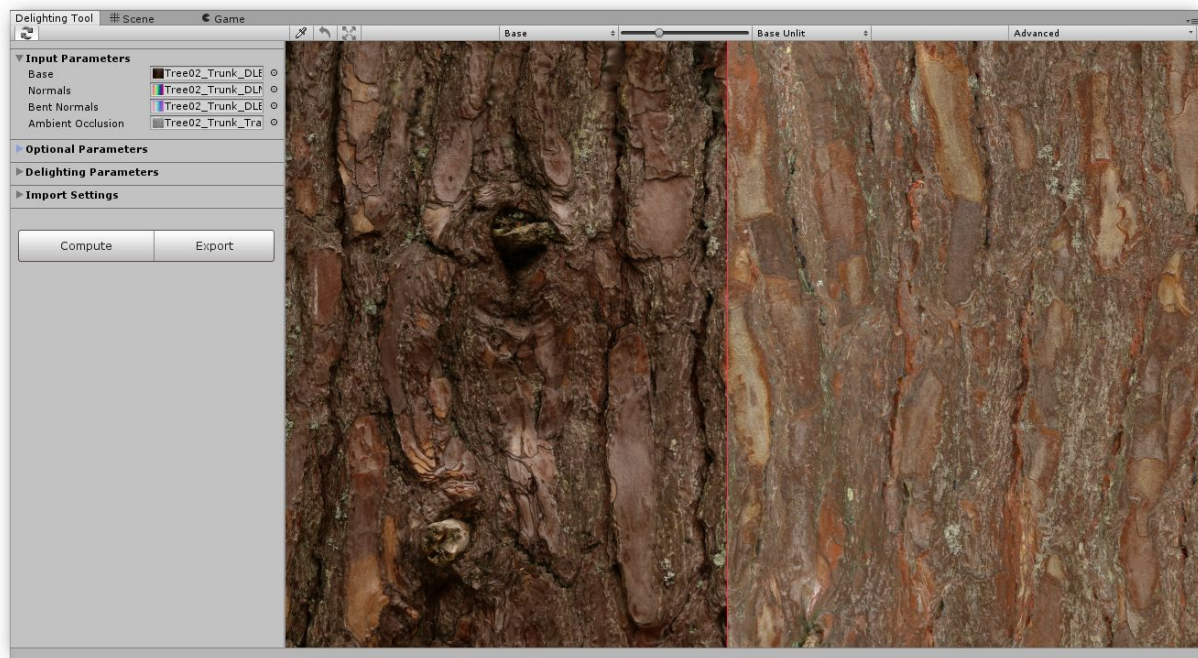# Experimental Feature: De-Lighting Tool

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Table Of Contents

Introduction

In the CG industry, photogrammetry is becoming more and more popular. Being able to use a regular camera as a powerful 3D scanner opens an appealing way of creating realistic 3D assets. However, raw textures generated using this technique contain a lot of lighting information that should be removed. The Unity Package: De-Lighting Tool has been developed to solve this complex problem.

The De-Lighting Tool performs the following steps:
- Environment Lighting Reconstruction
- Image-Based De-Lighting
- Ambient and Global Illumination Lighting Removal
- Exposure Compensation and Color Correction

After performing the aforementioned steps, the tool produces a "de-lighted" texture. Additionally, it also can output an environment map in the LatLong format which can be used for debugging or validation.
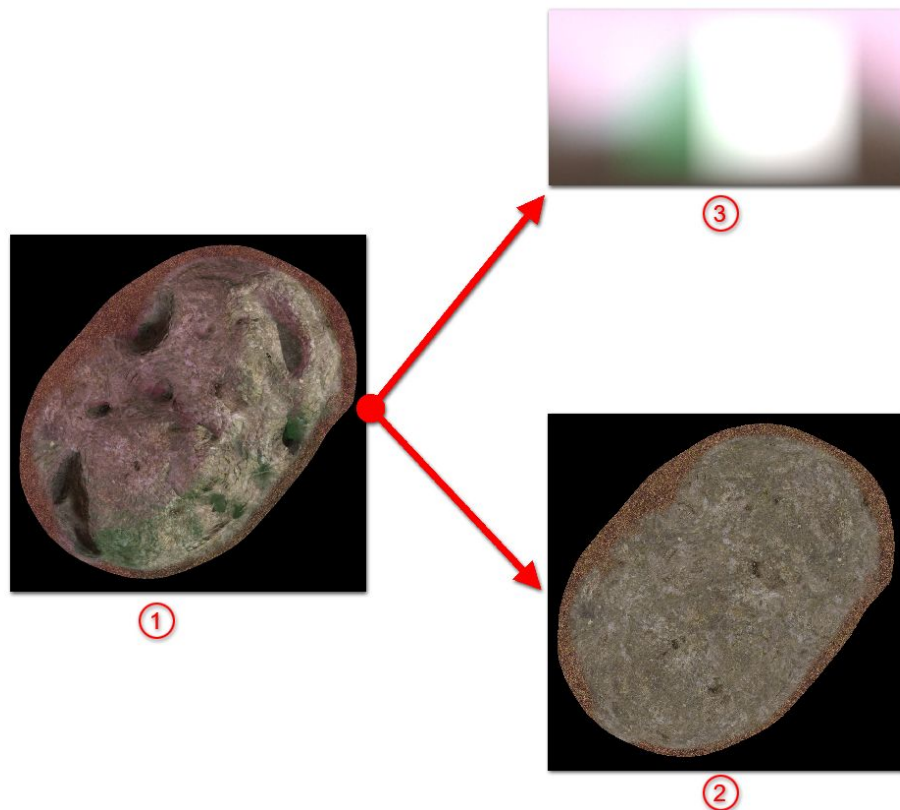
(1) Input Texture with lighting information created from photogrammetry, (2) De-Lighted Texture, (3) Environment Lighting in LatLong coordinates

Lit and de-lighted object

Experimental feature Disclaimer

De-lighting tools is experimental: its contents and features are subject to modifications. Results can vary and it is not guaranteed that the output delighted texture is correct. Because it implies a few specific project settings (Custom asset processor and color space), it is recommended to make a dedicated Unity project for the De-Lighting Tool.

Version Requirements

The De-Lighting Tool is compatible with **Unity 5.6** and above. It is intended to work with **Linear Color Space** project configuration.
To switch to Linear Color Space, go to: Edit / Project Settings / Player. Then, in the "Other Settings / Rendering" section set Color Space to Linear.

Installation

Download Unity

Download and install Unity 5.6 or above. The Download section should be accessed by following this link: [Unity Download Section](). More information on download and installation of Unity can be found here: [Unity Manual: Download and Install]().

Download Tool Project

The De-Lighting Tool project can be downloaded at:
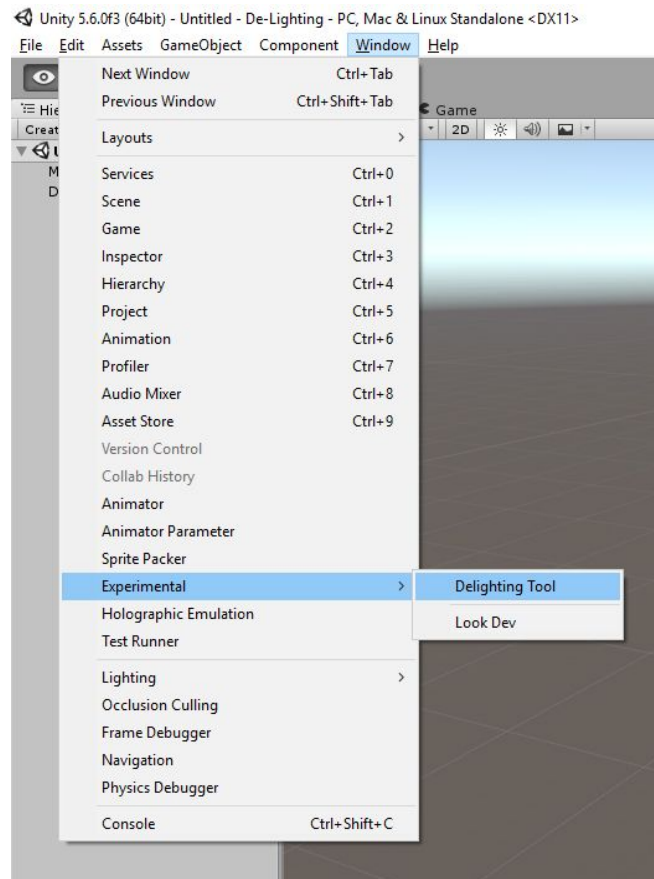[Unity Github]().

We recommend to have let the De-Lighting Tools as a separate project, and use it as a standalone software.
Once downloaded, unzip the project and use: File / Open Project in Unity
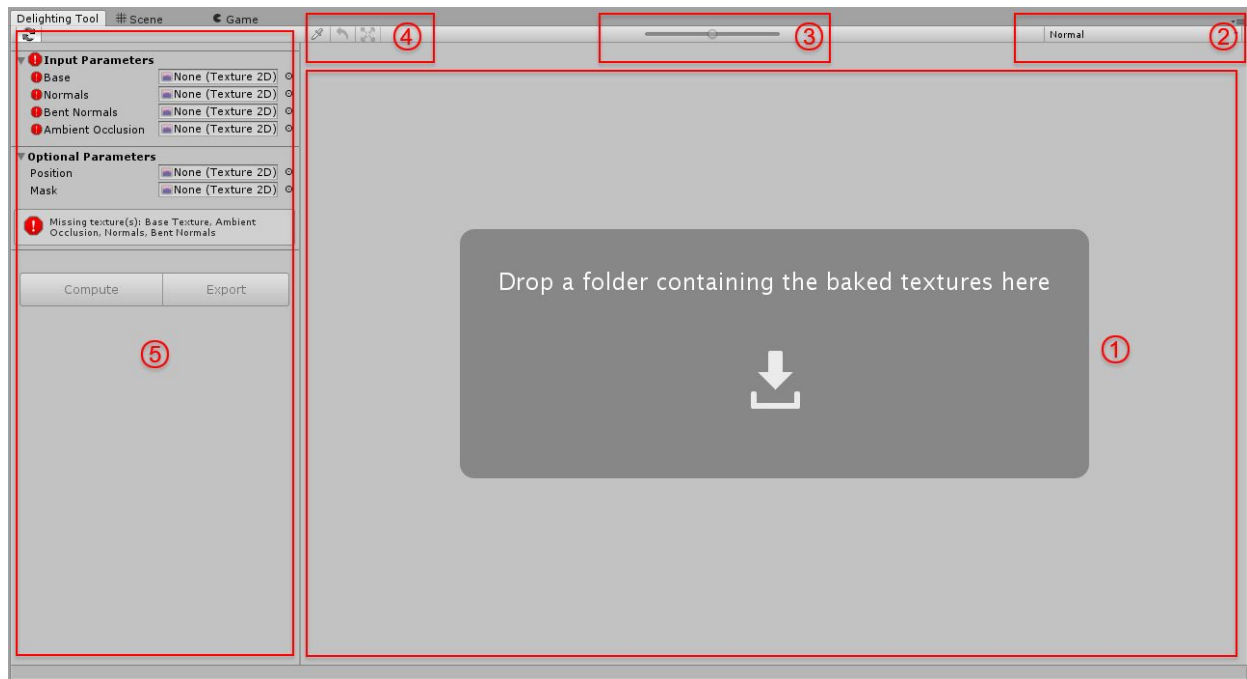
Tool Interface Overview

To Open the tool, go to Window / Experimental / Delighting Tool.

Once opened, the tool should look like this:

The Interface is splitted in 5 areas:

(1) - Preview

(2) - Interface mode switcher

(3) - Comparison slider

(4) - "Reference Zone" and "Fit to View" buttons

(5) - De-Lighting Tool Inspector (Custom Inspector)

De-Lighting Workflow

The De-Lighting tool aims to remove the lighting that remains in 2D textures exported from photogrammetry software (Reality Capture, Photoscan ...).
The tool requires specific textures from baking softwares like:

- Ambient Occlusion map
- Normal Map
- Bent Normal Map

-   …

xNormal, Knald or Substance Designer are able to bake those specific maps.

Note: For Ambient Occlusion and Bent Normal Map baking, uniform and cosine distribution (or weighting in Knald) can be used. The baking context should be close as possible to the real context of the capture.
In Baking software, it is possible to reference a list of HD geometries instead of one. If the original object was on the ground, a ground mesh should be added in the list of HD geometries.

Import Data

The tool only processes and uses textures. Because the texture import settings can dramatically change the way a texture is interpreted, the tool generates texture auto-import scripts. This way, it's not necessary for the user to manage texture settings in Unity each time a new texture has to be processed. The only thing that should be done is giving the right suffix to the textures. By default, the naming conventions are:

*_DLBC.tga => Base Map: (RGBA) Original color texture to unlit   *(mandatory texture)*
*_DLAO.tga => (Grey) Ambient Occlusion Map   *(mandatory texture)*
*_DLN.tga => (RGB) Object-Space Normal Map   *(mandatory texture)*
*_DLBN.tga => (RGB) Object-Space Bent Normal Map   *(mandatory texture)*

*_mask.tga => (RGB) De-Lighting Parameter Map   *(additional texture)*
*_position.exr => (RGB) Texel Position   *(additional texture)*

In the Base Map, the alpha channel is used to mark the pixels that should be de-lighted. **If the alpha channel isn't correctly authored, the de-lighting result won't be correct.**

Using textures without this naming convention works fine but the user won't benefit from many available automations regarding textures.
In this case all texture settings have to be manually set like this:
Only the base Base Map (Diffuse Map) must use the sRGB import option. Maximum size should be 8k and compression should be set to none for all textures. Texture Type of all the maps should be set to "Default", even for normal maps.
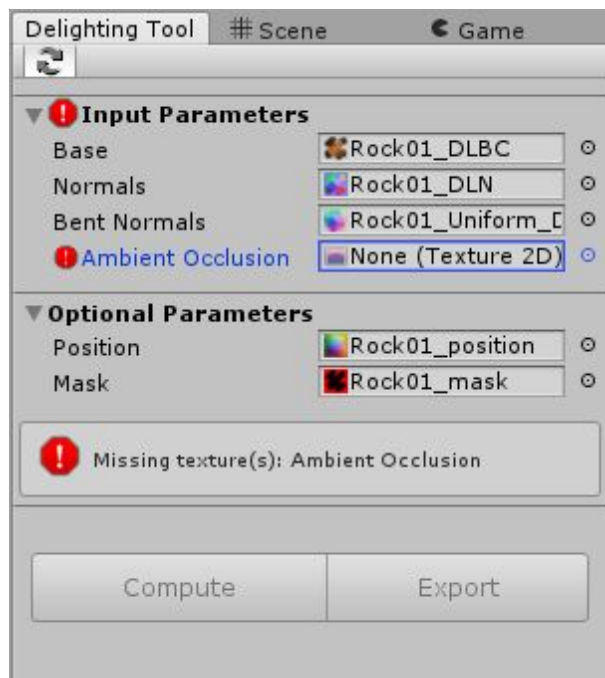
The user can change the naming conventions. This will be explained in this documentation later.

Process De-Lighting

Open the tool and drag and drop each required texture in the right slot.
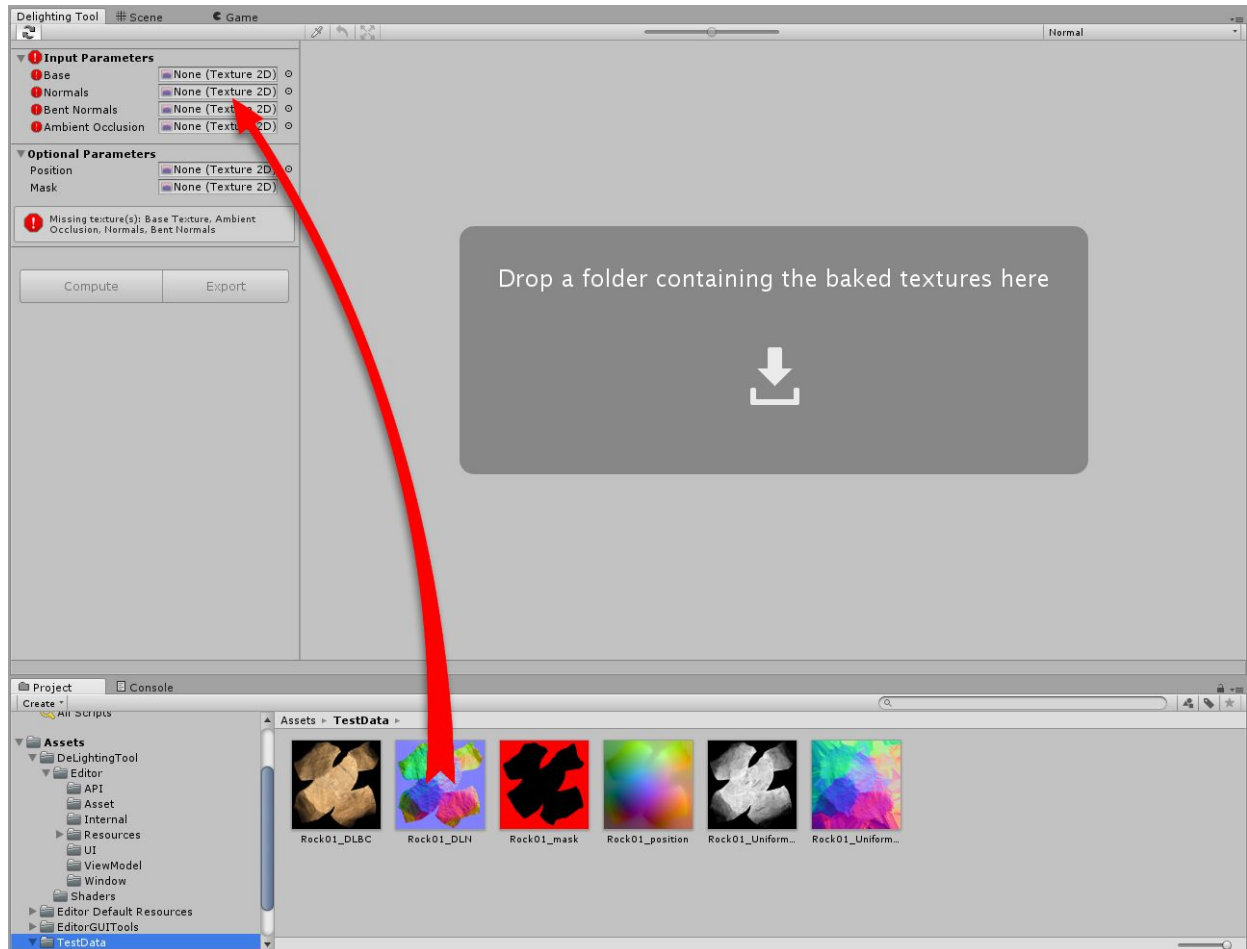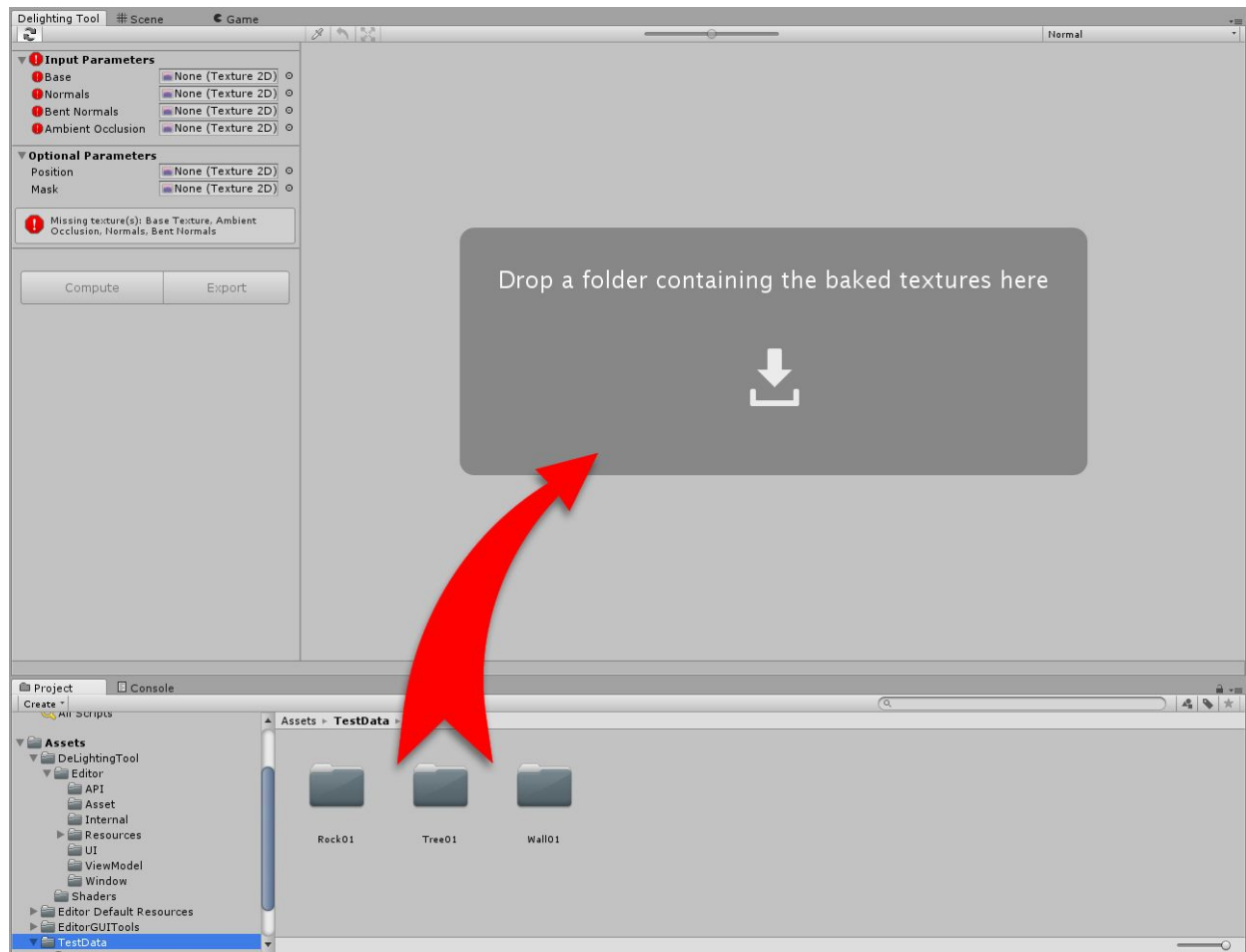

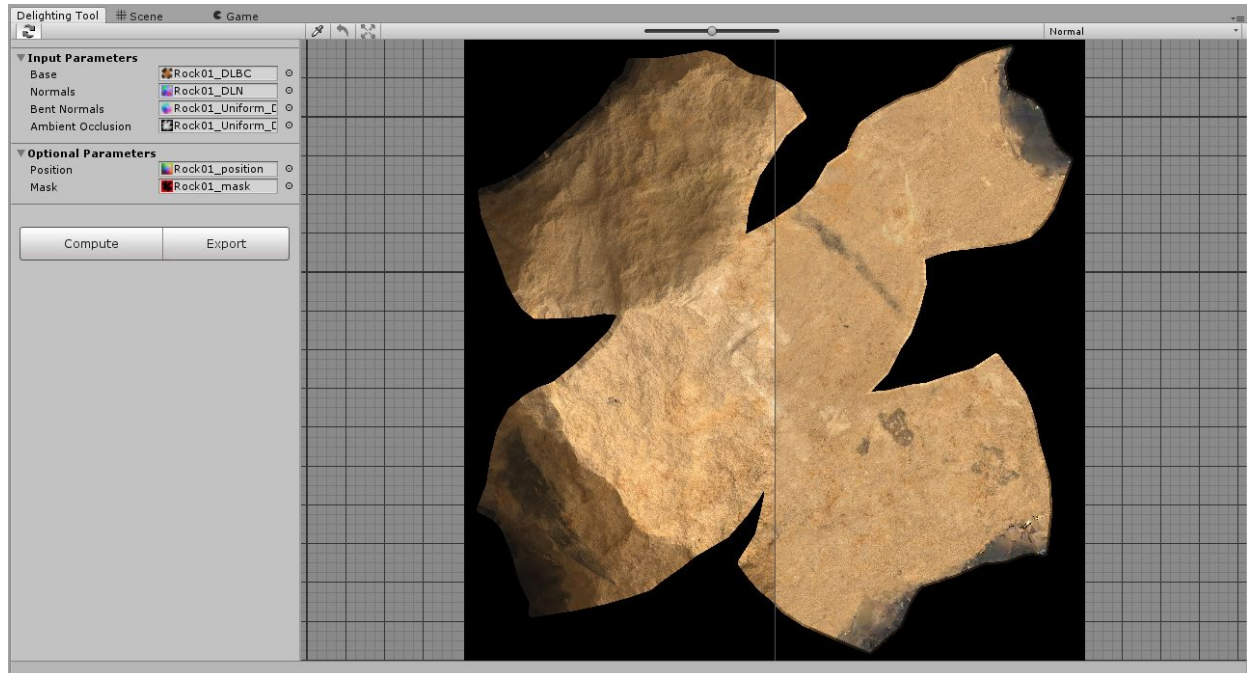An exclamation mark near a texture field means there is an error.

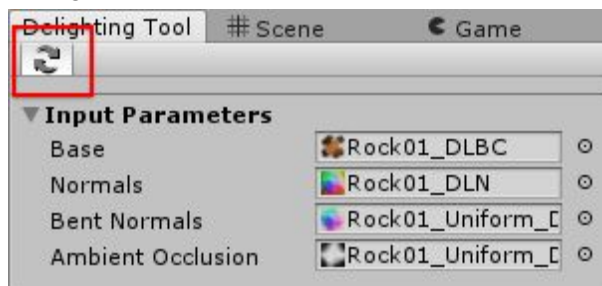Here, the Ambient occlusion texture is missing.

Another way to fill the texture fields is to drag and drop the texture folder in the preview area.

When the four textures in the "Input Parameters" section are filled, the tool processes the De-Lighting automatically.

If the Auto-Update button is pressed, the result will be updated each time a parameter is changed.

Evaluate the Result

The preview is split in two parts, the original texture is displayed on the left and the de-lighted result is displayed on the right. Moving the comparison slider move the preview splitter from left to right. The splitter can also be moved by left-clicking anywhere in the result picture.
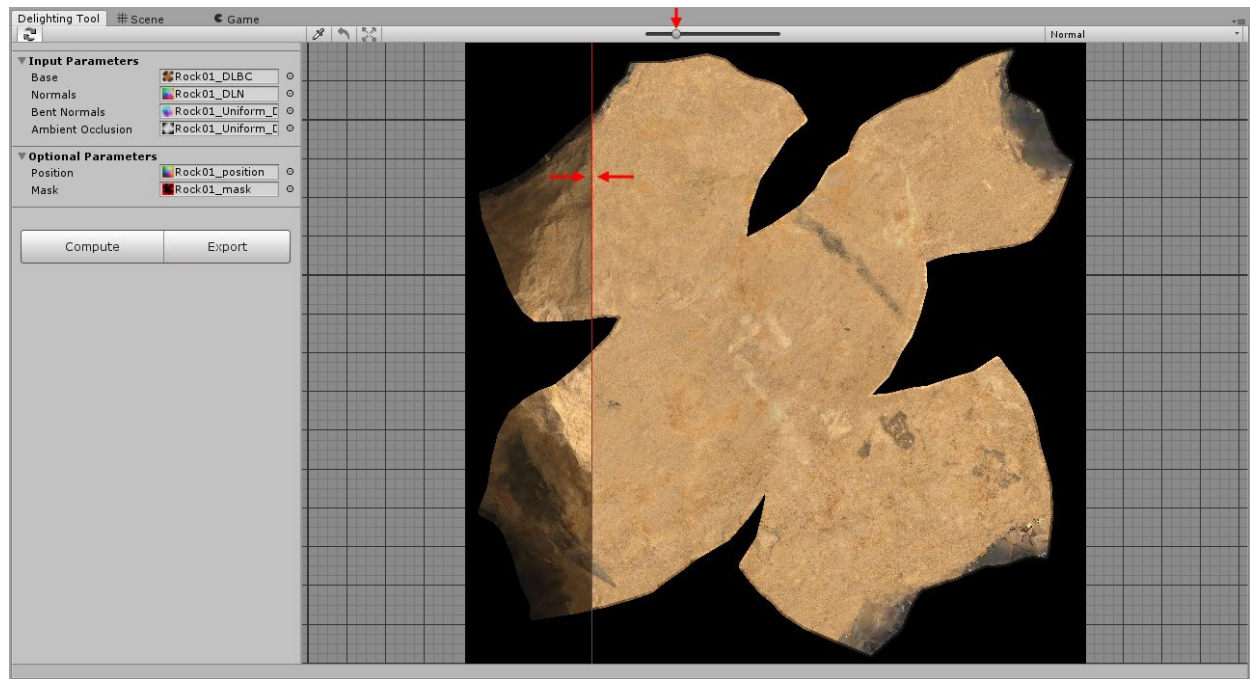
Navigate in the Viewport

Use Middle-click to **Pan** in the viewport. Use mouse wheel to **Zoom**-in and out.
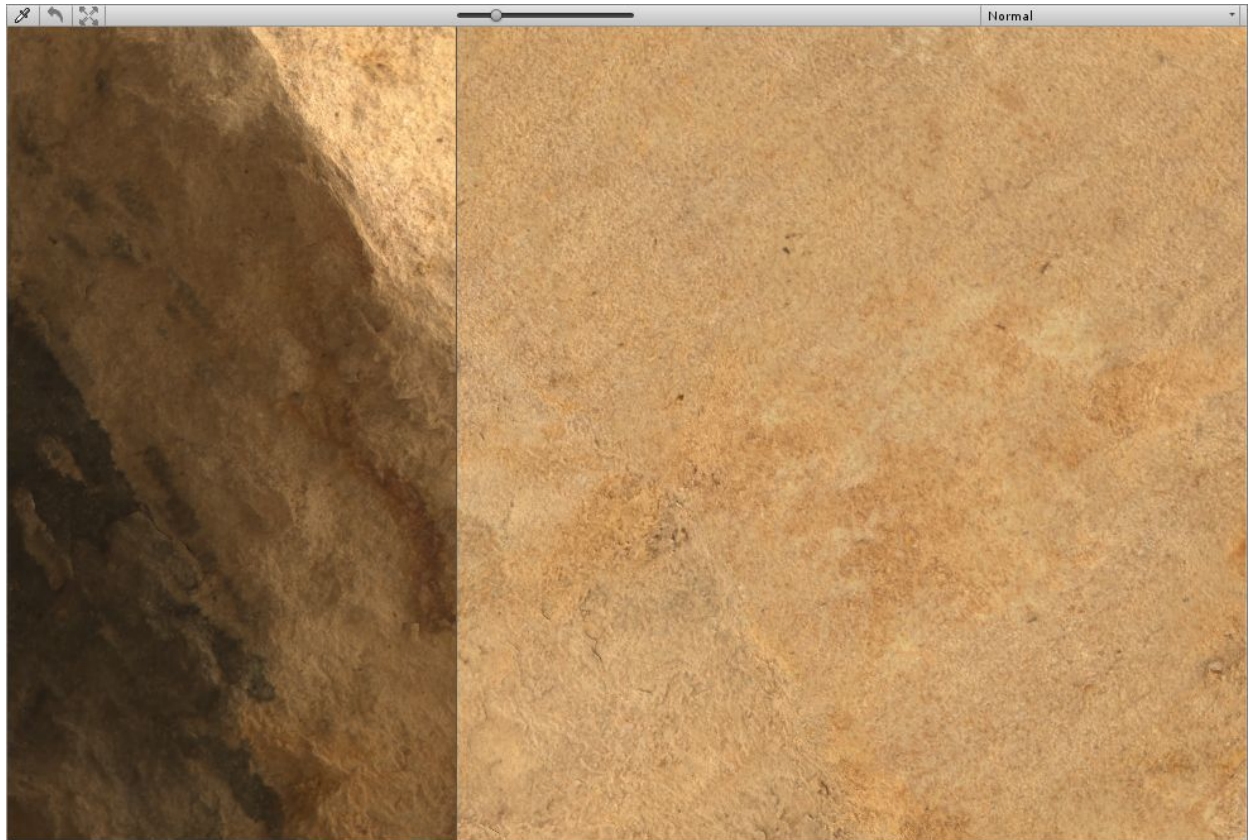
Press the "Fit to View" button on the top left of the preview to reset pan and zoom.
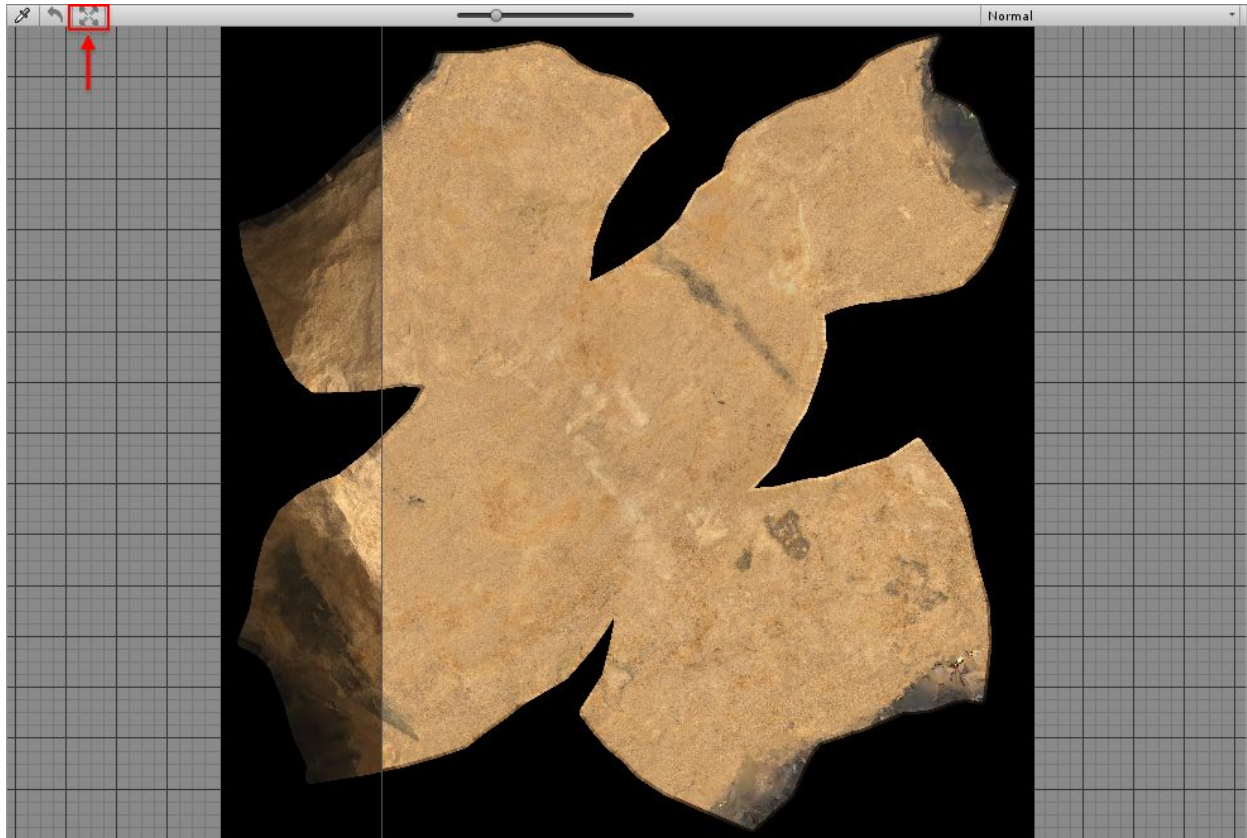
White Balance and Exposure: The Reference Area

If the texture has been color calibrated ([White Balancing](#)), the reference area (i.e the area around the colorchecker used for the calibration) could be used to get a result that is closer to the real object albedo color.
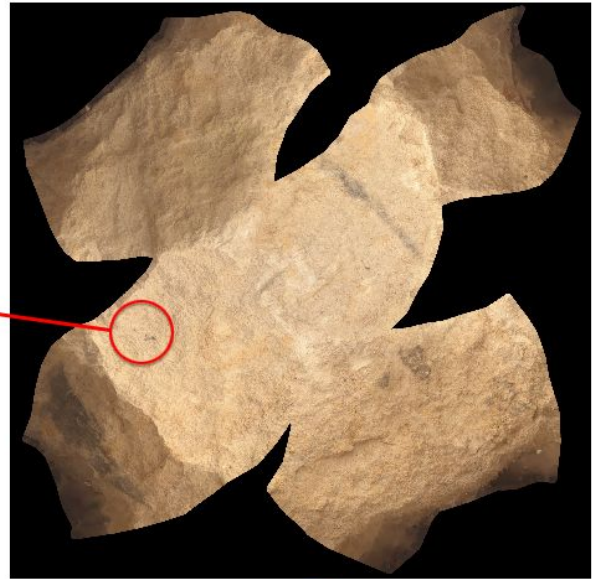
(1) Calibrated Photo, (2) Calibrated Texture (the red circle mark the calibrated area)

To activate the reference area, press the picker button on the top left of the preview. The "Reference Area" gizmo is displayed as a red dot with a green circle around.

Move the gizmo by left-clicking on the red dot, and place it where the color checker was placed.

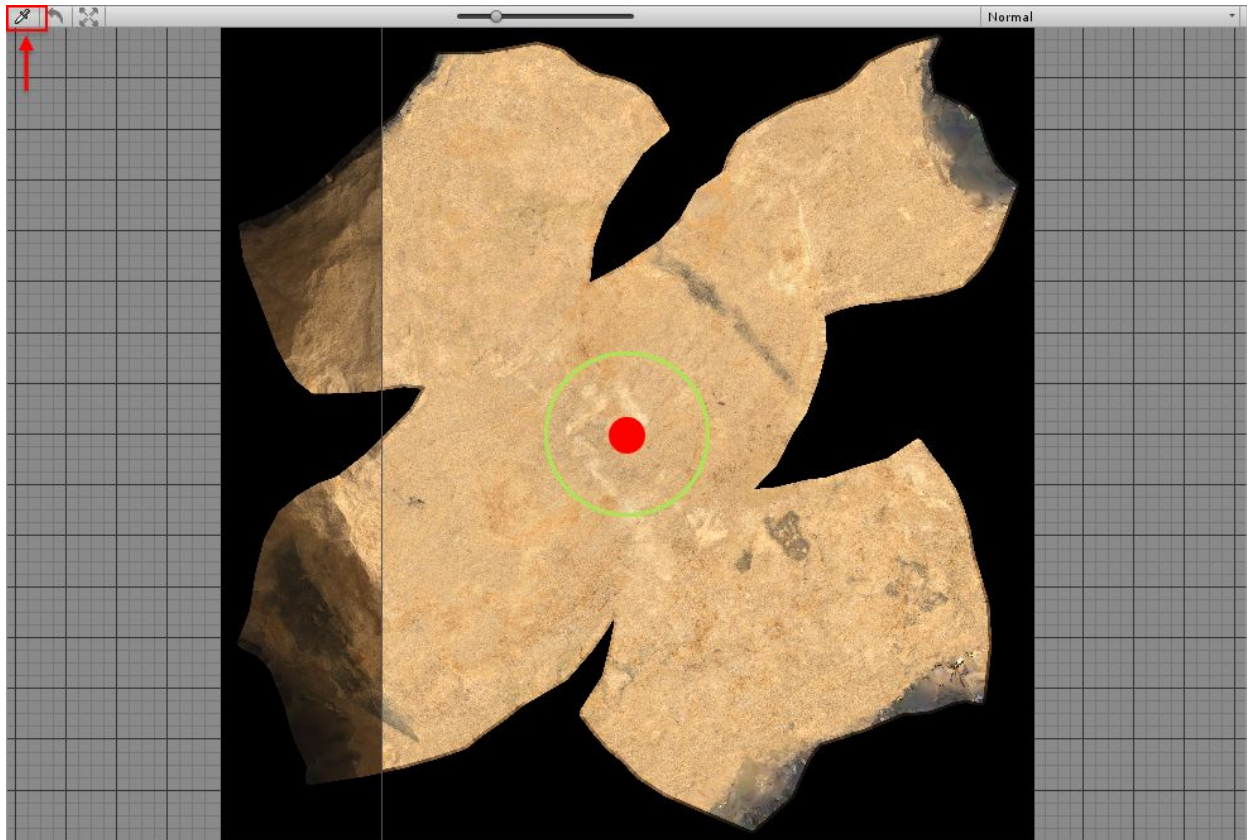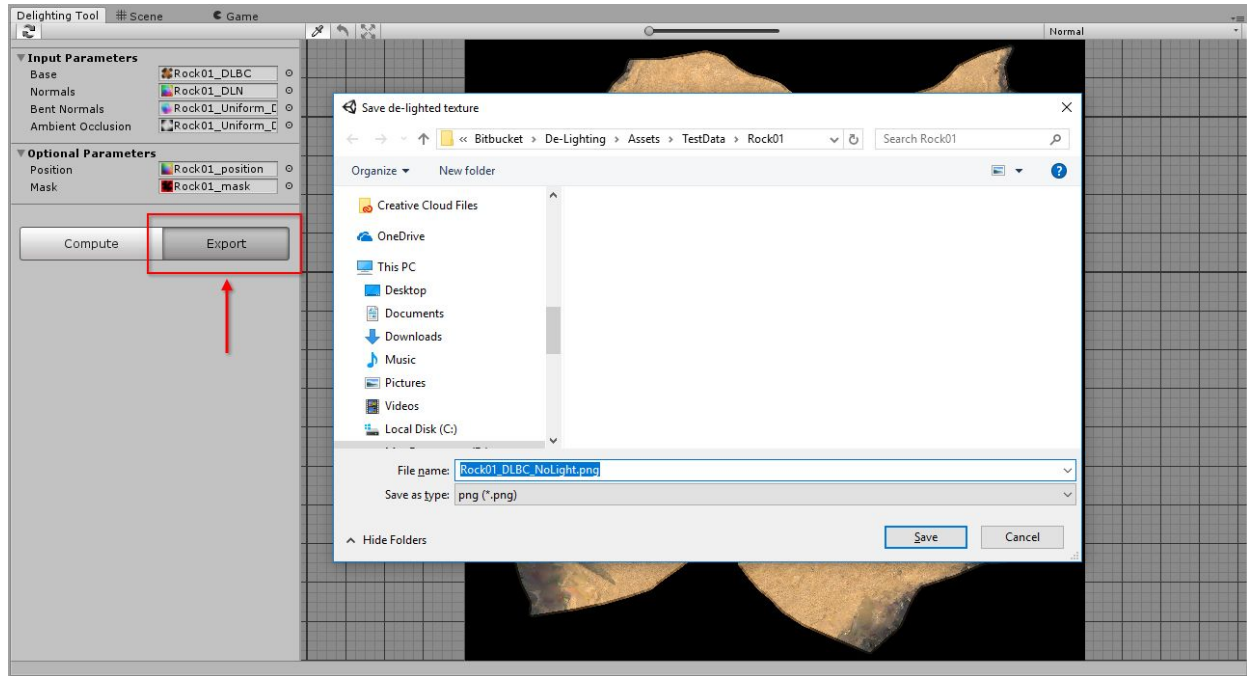*(Here the compare slider has been set to the maximum left to see only the de-lighted texture.)*

Change the size of the green circle by dragging it. This circle indicates the size of the calibration area. Color and exposure should change when the gizmo is moved.

Result Export

Simply press the Export button in the inspector to save the result as a .png file.

Advanced De-Lighting

Optional Parameters

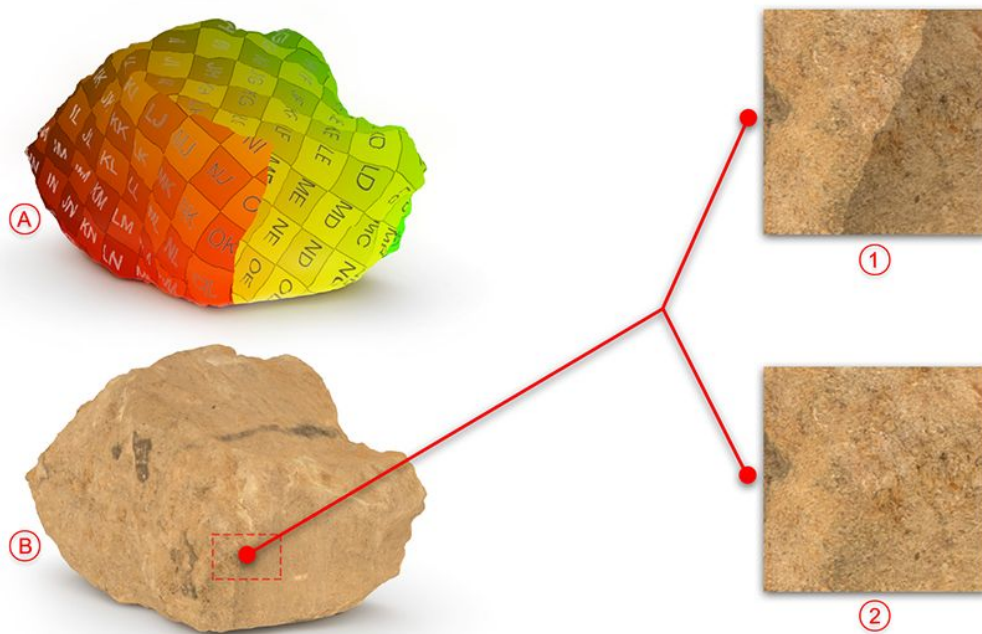### The Position Map

The de-lighting process can also be done in 3D instead of 2D (UV Space) by using a Position map. The first benefit is to avoid discontinuities that can appear upon UV seams during the de-lighting process. The second benefit is a more consistent and more accurate de-lighting.

Note: set to "normalized" (using bounding sphere if available) the position map in the baking software.

(A) Object UV coordinates, (B) Object with De-Lighted texture
(1) Without position map: visible UV seams, (2) With position map: invisible UV seams

The Mask Map

The mask map is a RGB texture that should be authored with a 2D software like Adobe Photoshop. Each channel value drives a different parameter of the de-lighting process.

The red channel

The De-Lighting Tool is using the surface itself to reconstruct the environment lighting (i.e a light probe).
The environment lighting is reconstructed based on the pixels that come from the same material: this will be called the reference material. It doesn't need to be exactly identical but **very different material parts should be marked in the red channel**.

In the case of this rock, most of the appearance comes from a very similar rock material but a few black parts are paint material and not rock.
In the wild, many materials like snow, sand or even moss… can cover the objects (they are often oriented upward due to gravity or light) and they can perturb the de-lighting process.
Those materials should be marked in the red channel of the mask.
The parts that have been incorrectly reconstructed by the photogrammetry process should be masked as well.

The example below show the texture that should be de-lighted and the 3D mesh that will use it.

(1) Original lit texture, (2) Lit texture applied onto the mesh

To begin, the de-lighting process is done without using a mask (or an empty mask). Red arrows show where artefacts appeared.
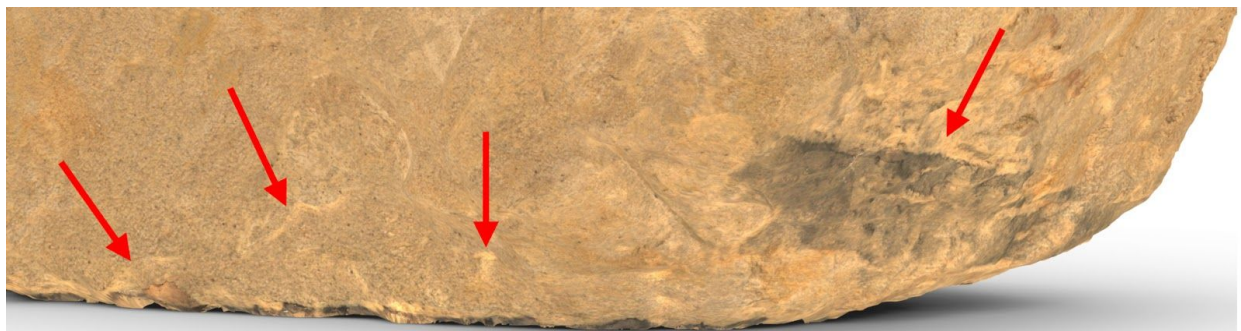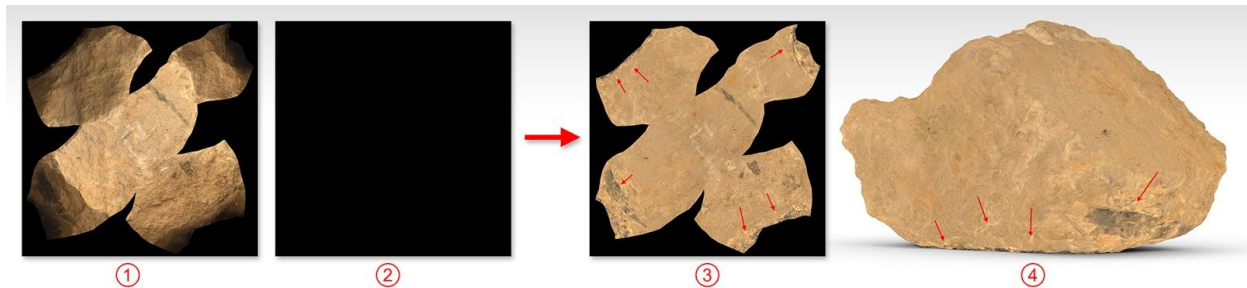
(1) Original lit texture, (2) Empty mask, (3) De-lighted texture, (4) De-lighted texture applied onto the mesh

It's time to edit the red channel of the mask. First, the badly reconstructed parts of the lit texture are marked in the red channel. Most of arrows turn to green. It means that the artefacts have disappeared, and those bad parts was responsible of nearly all the de-lighting problems. But there is still one red arrow near a black painted area of the rock.
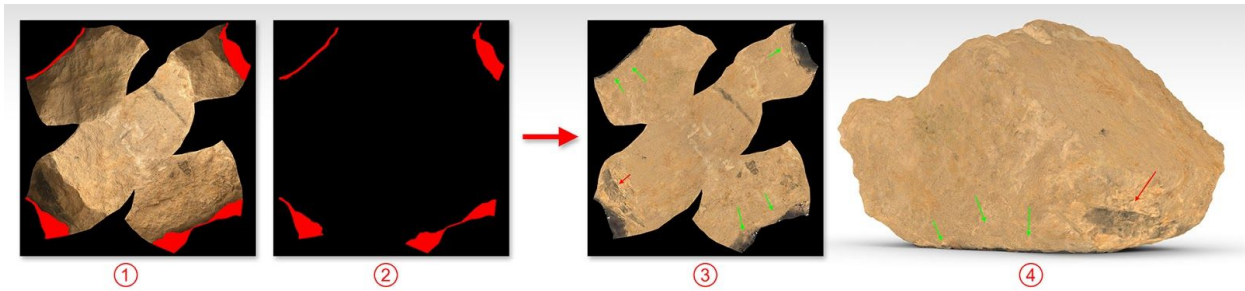
(1) Preview of the authored mask over the original Texture , (2) Authored mask, (3) De-lighted texture,
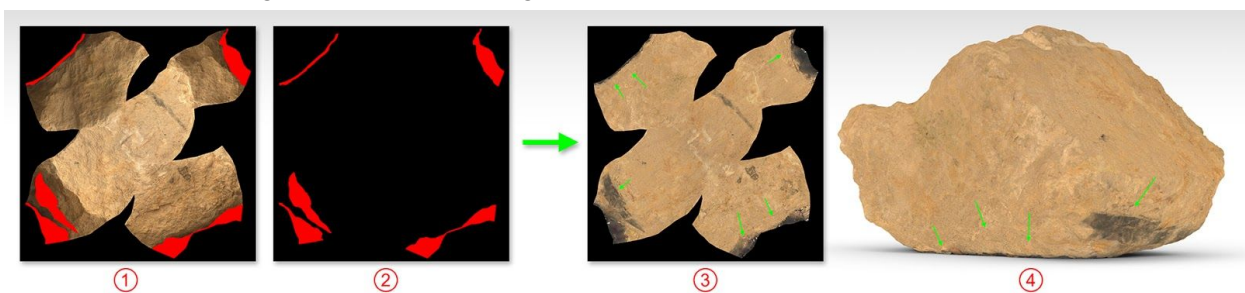*(4) De-lighted texture applied onto the mesh*

The large black paint mark is very different from the rest of the object. It can be considered as a very different material. The black part is marked in the red channel (in the bottom left of the mask), so it will be considered as a non-reference material by the tool.
All arrows turned to green, artefacts are gone.

(1) Preview of the authored mask over the original Texture , (2) Authored mask, (3) De-lighted texture, (4) De-lighted texture applied onto the mesh

It's not necessary to mark all the parts that are small or slightly different. Iterating on the mask authoring is a good way to correct artifacts one after another. The picture below shows the de-lighted result **without** using mask. On this side of the rock, there is almost no visible artifacts.
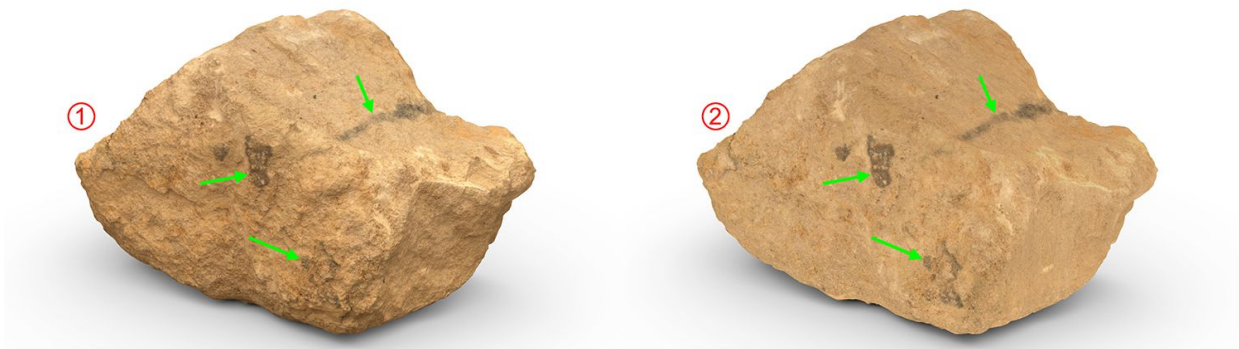
*(1) Original Texture - applied on the mesh, (2) De-lighted texture **without** mask - applied on the mesh*

If non-reference materials are more than 30% of the pixels, it can be necessary to do de-lighting in two passes (or more). The first pass is the one described previously, and the second one with an inverted red channel. The two results should be exported and recombined in a 2D software like Photoshop.

The green channel

The reconstructed environment lighting is stored in a spatial structure that separates global and local lighting (see Technical paper for more information).

Local Lighting is coming from near objects (e.g. ground) or from the bounce of light on the object itself (self global illumination). Everything else is considered as global lighting. The De-Lighting Tool uses the ambient occlusion value to estimate if it needs to use local or a global lighting. More occlusion means more local lighting, less means more global lighting.

Sometimes ambient occlusion is not enough to select between local and global lighting. **The green channel forces the use of local lighting in a specific area of the texture.**

Note: Local de-lighting is less accurate than global de-lighting to separate light color and material albedo. This means that increasing the use of local de-lighting on too much part of the image can decrease the accuracy of the result.

Similarly as the previous example, this one shows the texture that should be de-lighted and the 3D mesh that will use it. For a better visualisation, the texture has been slightly increased.

(1) Zoomed Original lit texture, (2) and (3) Original lit texture applied onto the mesh

The previous step has already been done. The red channel of the mask has been edited to mark pine cones and needles as a non-reference material.
Although the use of the red channel, the result isn't perfect in the areas (A), (B) and (C).
Those artifacts are mainly due to cast shadows that come from strong direct lighting. As it is described in the Photogrammetry Guide (Photogrammetry Acquisition and Process - 3.1.3), it is recommended to avoid strong direct lighting (e.g. the Sun) during the capture.
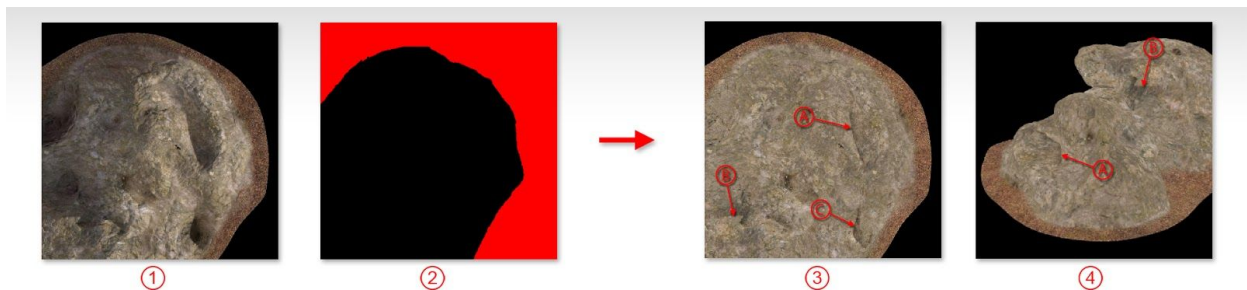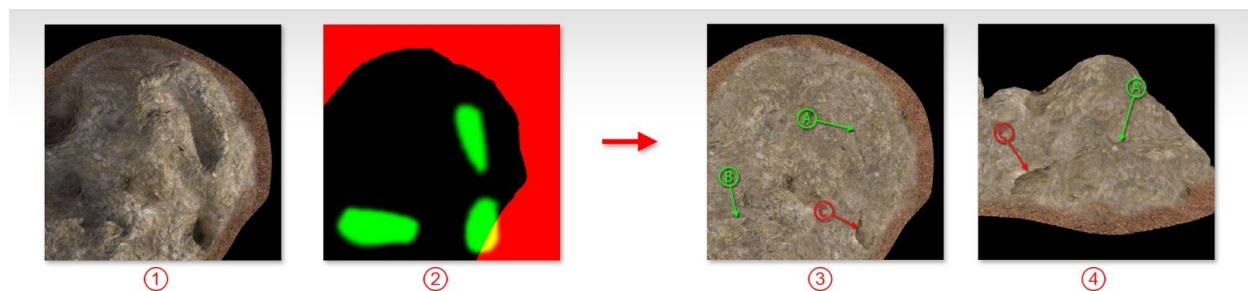

(1) Zoomed original lit texture, (2) Zoomed Mask, (3) De-lighted texture, (4) De-lighted texture applied onto the mesh

Using the green mask on this kind of artefacts can help to solve the problem. Artifacts (A) and (B) has almost disappeared.
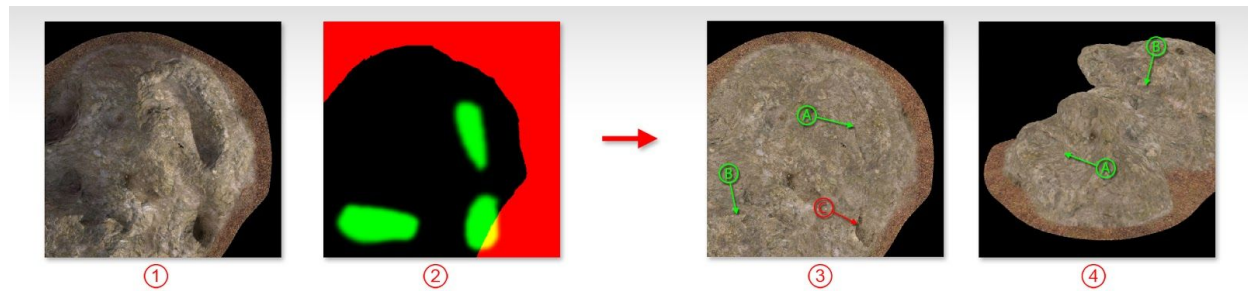

(1) Zoomed original lit texture, (2) Zoomed Mask, (3) De-lighted texture, (4) De-lighted texture applied onto the mesh

The artifact (C) is still remaining. Most of the time, strong cast shadows won't be removed from the texture, and it will be necessary to use a 2D software like Adobe Photoshop. For better visualisation of the area (C), the picture (4) shows the other side of the 3D mesh. Other pictures are the same as those above.
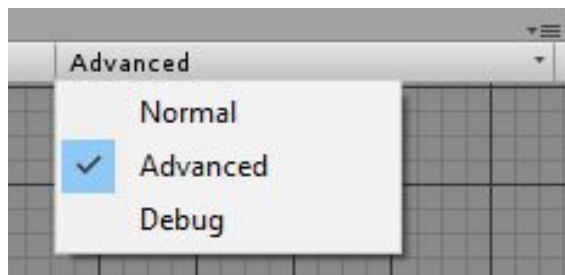

(1) Zoomed original lit texture, (2) Zoomed Mask, (3) De-lighted texture, (4) De-lighted texture applied onto the mesh

Advanced Mode
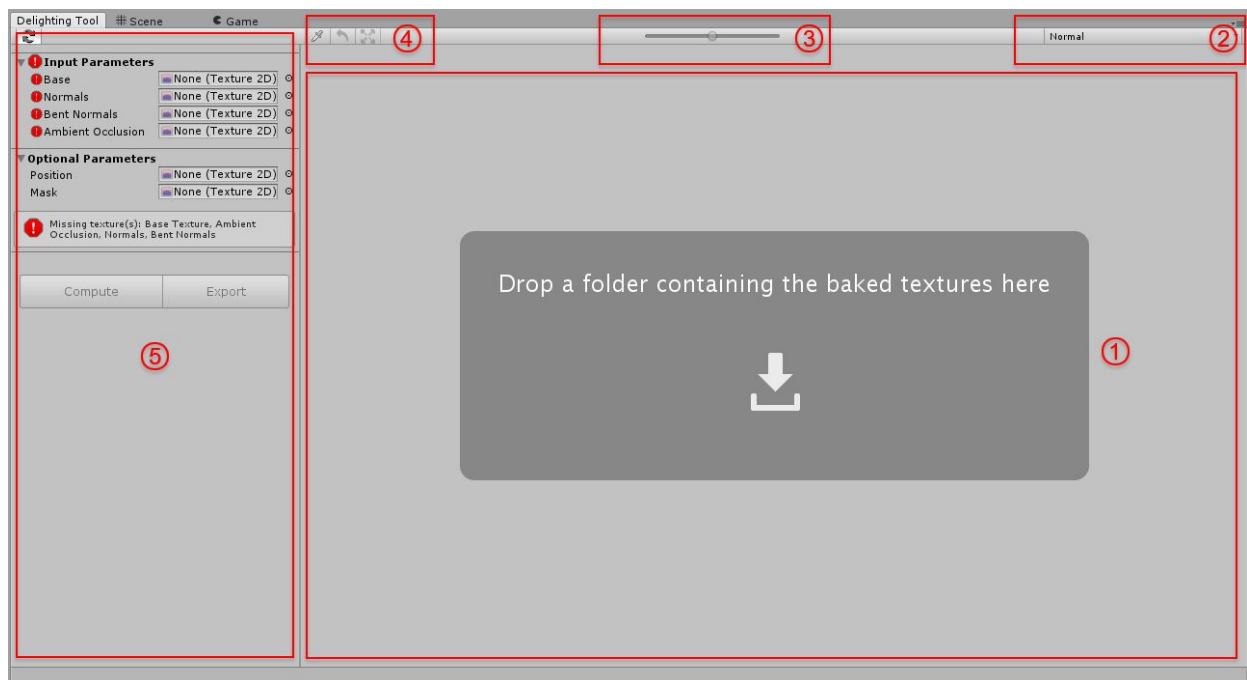
Zone (2) is the "View-Mode" drop-down list.

View-Modes display and hide interface elements to adjust the complexity of the appearance to the needs.

When the view-mode is switched to Advanced, interface elements and new feature are available.
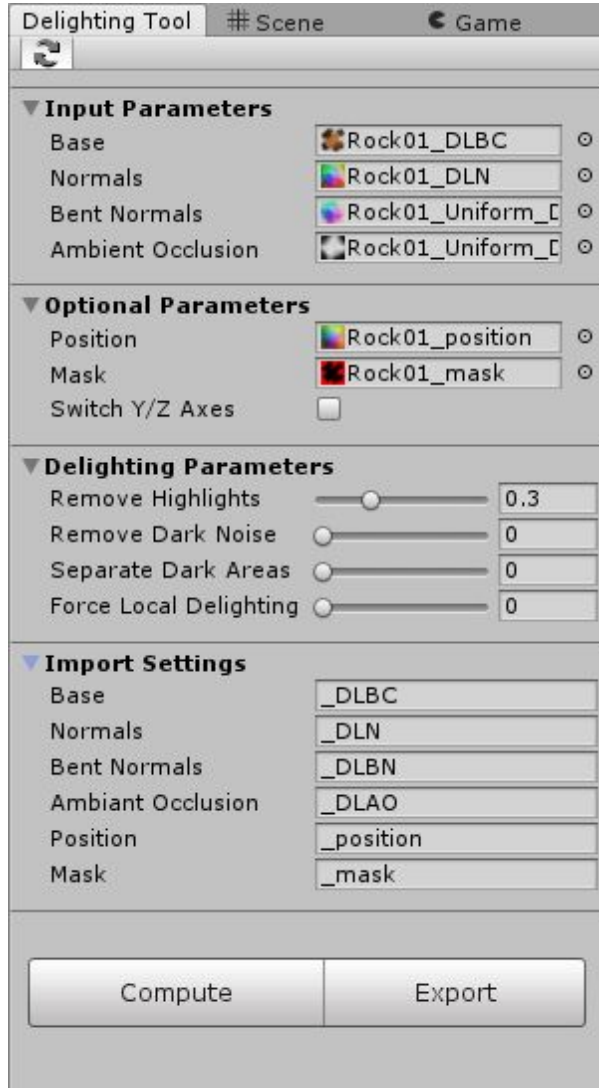
Optional Parameters

In optional parameters, a new checkbox appear: Switch Y/Z axis. This feature allows the tool to be consistent with the normal data provided (normal map, bent normal map).

De-Lighting Parameters

This section exposes parameters that are useful to correct artifacts.

Remove Highlights

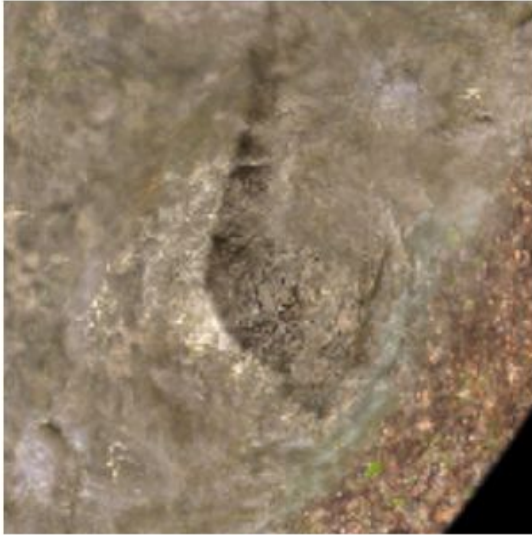This slider goes from 0 to 1, controls highlights detection and processes de-lighting repair on those parts. Those highlights can appear for many different reasons, and most of the time a 0.3 value is enough, that's why it's the default value. Increasing the value too much makes the de-lighting process less accurate. It's best to try to keep it as close as possible to 0.
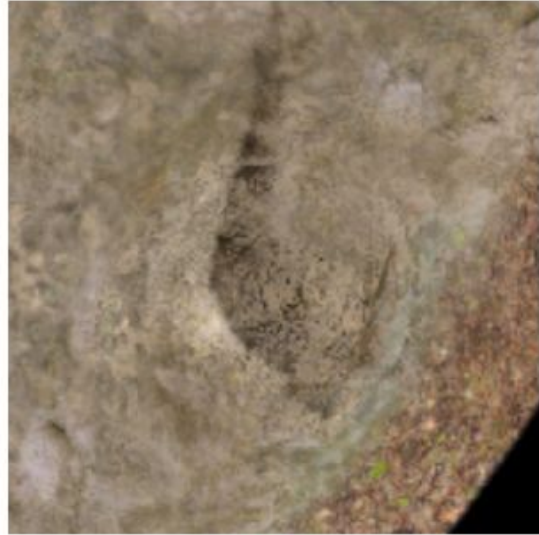
(1) Remove Highlights value = 0   *(2) Remove Highlights value = 0.3*

Remove Dark Noise

This slider goes from 0 to 1. Small black dot can appear for the same reasons as for the highlights. Use it the same way as the "Remove Highlights" slider.

(1) Remove Dark Noise value = 0   *(2) Remove Dark Noise value = 0.3*
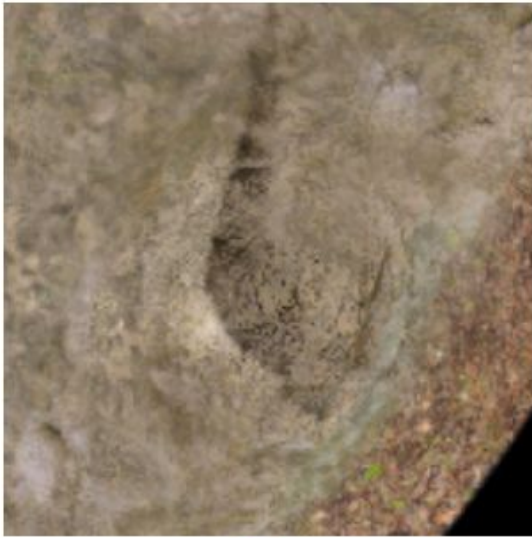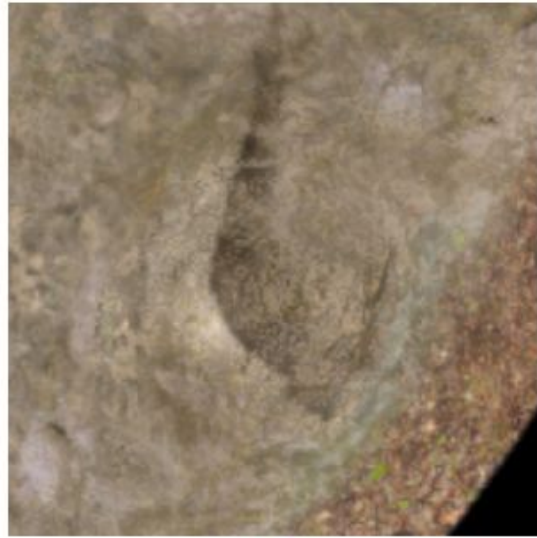
Separate Dark Areas

Photogrammetry is less accurate in dark areas, all the informations in those parts (normal, bent normal, ambient occlusion) won't be as consistent as others. To get better result, it sometimes interesting to separate dark parts from the rest of the texture. A slider value of 0.2 separate all the pixels that have a luminance value lower than 0.2 (if we consider that maximum luminance is 1). It could be considered as a procedural mask of dark areas.

Force Local De-Lighting

This slider control the same parameter as the [green channel](#) of the mask. As described in the green channel section, when the slider goes from 0 to 1, the tool use more local lighting information instead of global. Pushing the value to 1 can provide a feeling that the texture is more de-lighted but the reality is that result is less accurate.
This slider and the green channel value are cumulative, so, if the green channel is half grey and the slider is 0.5, the parameter will be equal to 1.

Import Settings

As it is described in [Import Data](#) chapter, this section expose the name suffix that should be used to make the tool correctly import and automatically recognize textures (e.g. during folder drag and drop). Changing those suffixes will generate new import rules. If there is already import rules (AssetPostprocessors scripts), it's important to check that the suffixes are not in conflict with those used by the De-Lighting Tool.

Comparison channels

Switching to Advanced Mode also add new comparison channels in the viewport.
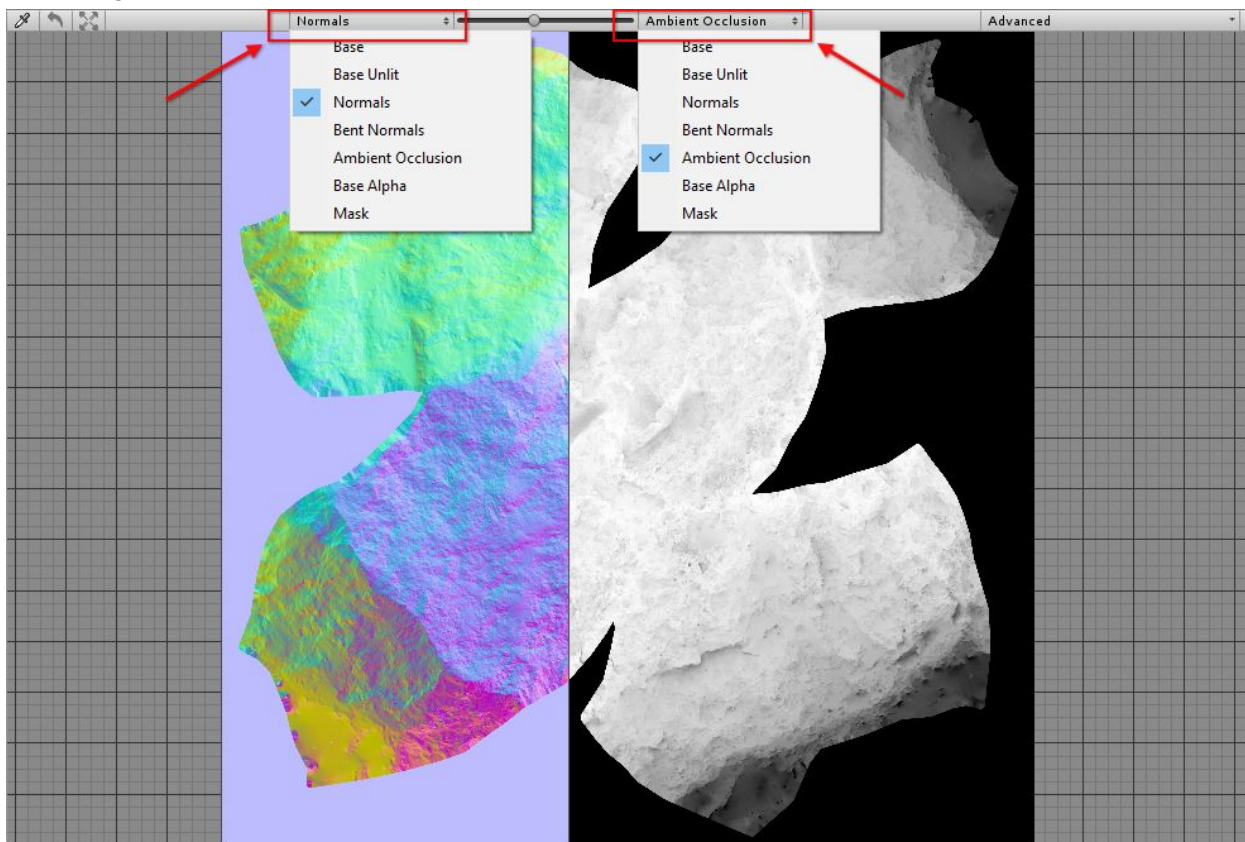
On both sides of the comparison slider, there are two dropdown lists that control which channel to display on left and right side of the viewport splitter. By default, left side is set to Base (Original lit texture) and right side is set to Base Unlit (de-lighted texture). They can be switch to Normals, Bent Normals, Ambient Occlusion, Base Alpha (alpha channel of the Original Lit Texture) and Mask.

Debug Mode

Switch view mode again To Debug. The inspector should looks like the picture below.
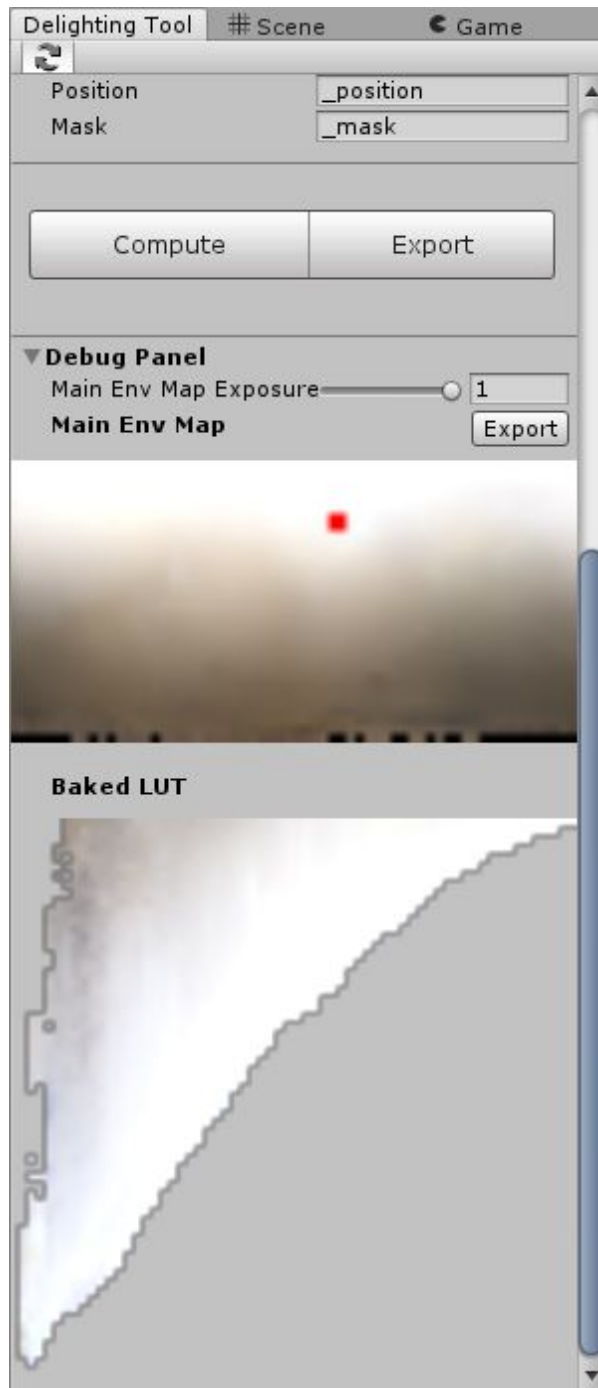
Features available in this mode are designed to understand what went right or wrong in the de-lighting process.

Main Env Map section

This section display the reconstructed global environment lighting as a 64x32 pixels LatLong image. This picture is HDR and can be exported to a .exr file by clicking the Export button.

The Main Env Map Exposure slider allow to change the preview exposure of the main env map.

The Red Dot in the Env Map intend to debug the part of the Env Map the [Reference Zone](#) is pointing at. When the Reference Zone is activated, the pixels of the normal map under the gizmo are converted to an average Latitude-Longitude coordinates. The red dot on the Env Map is placed using those coordinates and indicate a white light reference.(see Technical paper for more information).

Neither the exposure shift value and the red dot will be displayed in the exported Env Map.

Baked LUT section

This section displays the Lookup table that is used for ambient lighting and self global illumination. This LUT is specific to every objects and it is generated each time a recompute is required. Its shape can give useful informations to know if bent normal map and ambient occlusion map are consistent.

Baked LUT
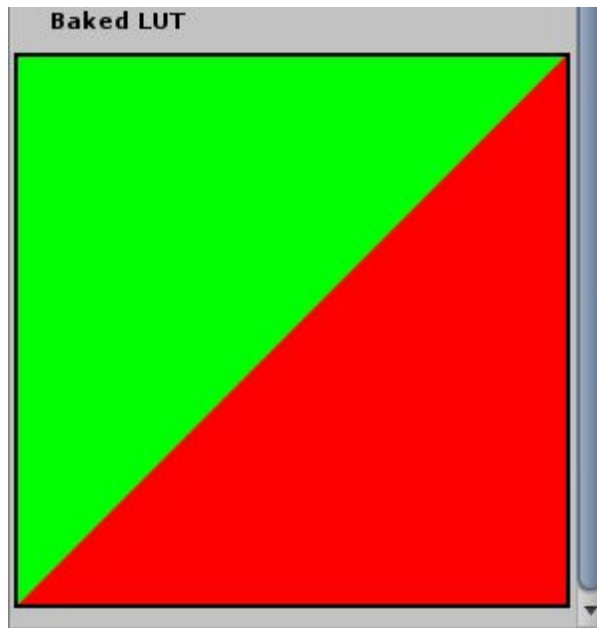
90 % of the pixels should be in the green area. They don't have to cover the whole area, they need to be inside.

If there is a lot of pixels in the red area, there is probably a problem with ambient occlusion map and/or bent normal map.

In this case, verify that those maps have been baked and imported with correct settings.

Because all the baking softwares don't work exactly the same, it is recommended to use only one of them to bake all the maps.

Command-Line

The De-Lighting Tool can be launched via command-lines. Here are some examples of what can be done:

De-light a textures in a folder

```
.\Delighting.bat -output test.png -inputFolder Assets\TestData\Rock01
```

De-light by specifying all textures

```
.\Delighting.bat -output test.png -base
Assets\TestData\Rock01\Rock01_LRBC.tga -normals
Assets\TestData\Rock01\Rock01_LRN.tga -bentNormals
Assets\TestData\Rock01\Rock01_LRNB.tga -ao
Assets\TestData\Rock01\Rock01_LRAO.tga -position
Assets\TestData\Rock01\rock01_position.exr
```

From a batch script

```
CALL .\Delighting.bat -output test.png -inputFolder Assets\TestData\Rock01

You can define some parameters:
-separateDarkAreas <float>
-forceLocalDelighting <float>
-removeHighlights <float>
-removeDarkNoise <float>
-switchYZ (true|false)
```

Photogrammetry Guidelines

A photogrammetry guide "Photogrammetry Acquisition and Process" will be available soon and explains deeply the photogrammetry process.

Capture:

During the capture, it is necessary to keep the same camera settings (except focus).

To be correctly white balanced, each picture should be color calibrated. Example of this are already available in ["An Artist-Friendly Workflow for Panoramic HDRI"](#)

> Page 46: "5 Linear reconstruction of HDRIs"
> Page 63: "5.8.1 White balance process"