



# SPACE WEEK

Our Planet • Our Space • Our Time

## Resource Book for Teachers TOPIC: Solar System Image Making

Missions to other planets have image portals where you can find the raw images from the spacecraft, rover or lander. These raw images can be combined in the free software GIMP to make colour images.

### Curricular links

Earth and Space 1 ... describe the relationships between various celestial objects including moons, asteroids, comets, planets, ...

Earth and Space 8 ... interpret data to compare the Earth with other planets and moons in the solar system, with respect to ... composition

Physical World 3 ... investigate patterns and relationships between physical observables

## Background Information:

This guide looks at making your own Mars or Jupiter images by digitally combining grey images. This material can be used to support the study of colour vision (see [Color Vision 1.1.25](#)), the mixing of light, pixels and cameras (see [this Primary Resource from ESA](#)), as well as with the study of the Solar System. GIMP is at <https://www.gimp.org/>.

**Mars Perseverance Images:** from <https://mars.nasa.gov/mars2020/multimedia/raw-images/>

### Engineering Cameras

New raw images appear daily. Choose Image Type Raw and choose one of the four **Hazcams** to find three grey images that are of the same scene. These images have been taken with the camera and may have R or G or B in the start of their name. You will want three (one R, one G and one B) that match the same scene.

FRR\_0000\_0666958220\_664ECM\_N0010052AUT\_04096\_00\_213J01\_320

FRG\_0000\_0666958226\_808ECM\_N0010052AUT\_04096\_00\_213J01\_320

FRB\_0000\_0666958242\_147ECM\_N0010052AUT\_04096\_00\_213J01\_320

In this case the final three digits give the size of the image – these are small images at 320 pixels. Larger images can be found by clicking on the image to see the full caption and downloading from that page (use the download button).

Mars\_Perseverance\_RLR\_0002\_0667129466\_057ECM\_N0010052AUT\_04096\_00\_213J01

Mars\_Perseverance\_RLG\_0002\_0667129481\_373ECM\_N0010052AUT\_04096\_00\_213J01

Mars\_Perseverance\_RLB\_0002\_0667129492\_604ECM\_N0010052AUT\_04096\_00\_213J01

NASA Perseverance images are already in RGB format but have no colour in them. You can use GIMP to add the colour and combine the three grey images.

## Science Cameras

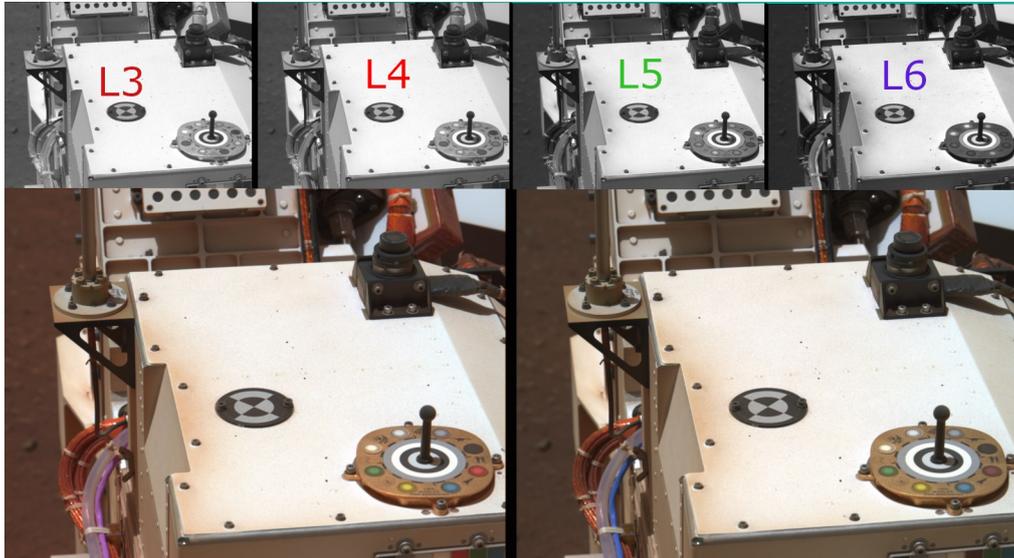
MastCam-Z- Left has filters that approximate human colours RGB. Look for L3 or L4 for a red image, L5 for a green image and L6 for a blue image.

Mars\_Perseverance\_ZL3\_0016\_0668361576\_536FDR\_N0030386ZCAM03002\_0480LMJ

Mars\_Perseverance\_ZL4\_0016\_0668361559\_545FDR\_N0030386ZCAM03002\_0480LMJ

Mars\_Perseverance\_ZL5\_0016\_0668361542\_536FDR\_N0030386ZCAM03002\_0480LMJ

Mars\_Perseverance\_ZL6\_0016\_0668361429\_542FDR\_N0030386ZCAM03002\_0480LMJ



Comparison of colour images made from (L3, L5 and L6) vs (L4, L5 and L6) from Mars Perseverance MastCam-Z-Left

MastCam-Z-Right has different filters. These can be combined in the same way – they might not look like the real thing – but that can be ok!

Details of what the file name characters mean is [here](#).

**Jupiter Images:** from <https://www.missionjuno.swri.edu/junocam/processing/>

JunoCam images are sorted into folders, each folder containing the raw image files: a map projected image and separate Red, Green and Blue files. Download a folder and extract it to get the R, G and B files.

JNCE\_2020365\_31C00055\_V01-red

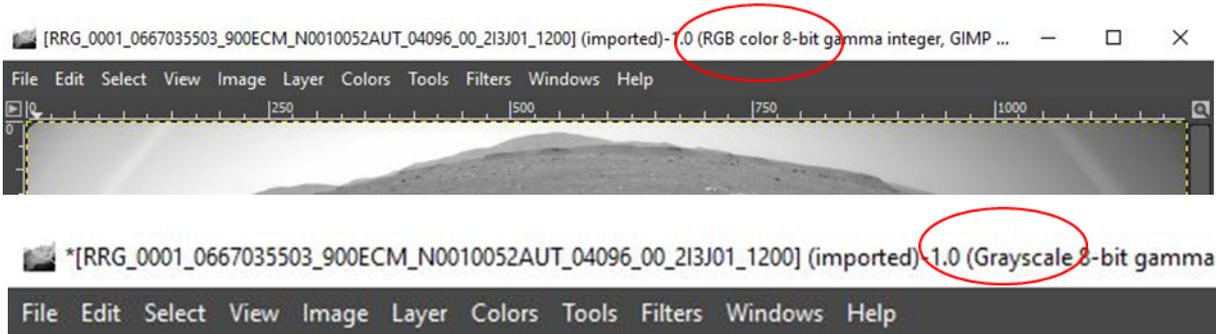
JNCE\_2020365\_31C00055\_V01-blue

JNCE\_2020365\_31C00055\_V01-green

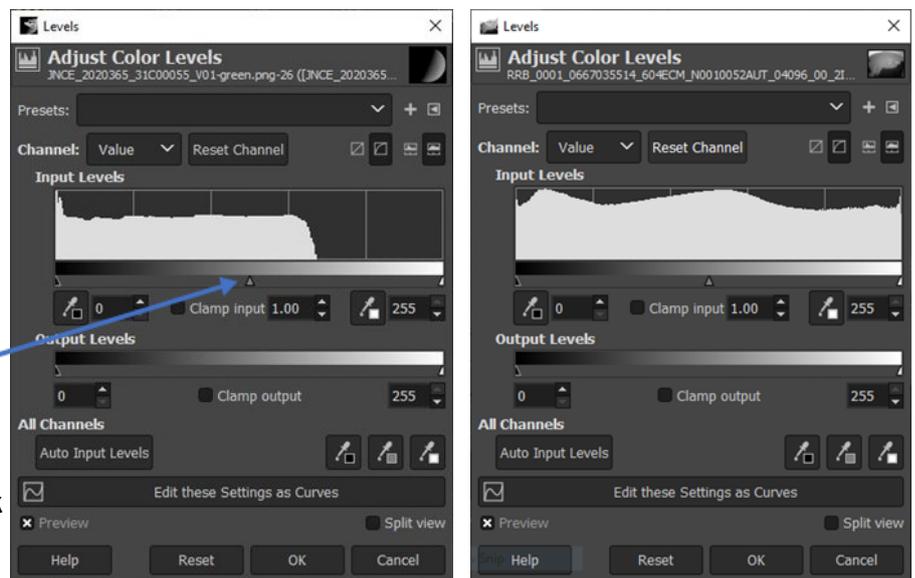
JNCE\_2020365\_31C00055\_V01-mapprojected – not needed

# Using GIMP to Make Colour Image

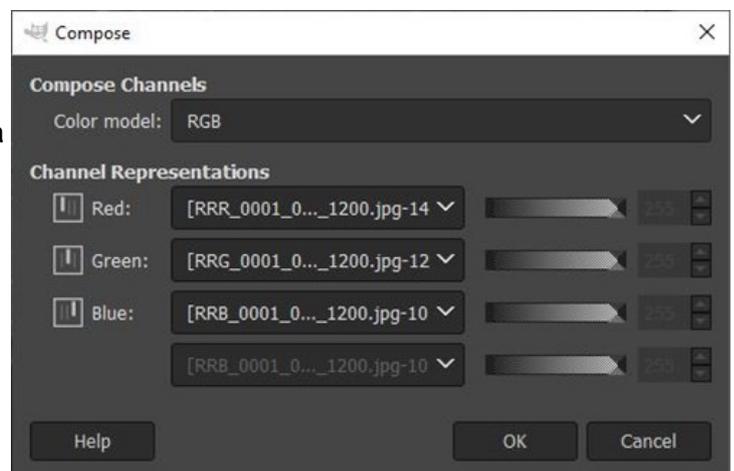
1. Open the three images in GIMP (tested in GIMP 2.10) **File>Open**
2. Check each image is grayscale, if not, then set to grayscale with **Image>Mode>Grayscale**



3. Check the **Colors>Levels** histogram. This shows the number of pixels of each brightness. If the image is very dark or very bright the histogram will not stretch across all possible input levels, this can be adjusted with the sliders. For some images you might need to move the grey centre pointer left or right, click ok. Open **Colors>Levels** again, move the black pointer to be next to the histogram (to keep the darks dark) and then adjust the grey pointer again. This can be repeated as needed and can be done for each colour file. The end product for each file should not be too bright, since the files will be combined and this process itself makes the finished image bright.



4. GIMP can **Compose** the grayscale files into a colour image by using each grayscale file as a channel. **Colors>Components>Compose** and choose from the dropdown the correct colour grayscale file for each channel. Red (or L3/L4) to red, green (or L5) to green and blue (or L6) to blue.

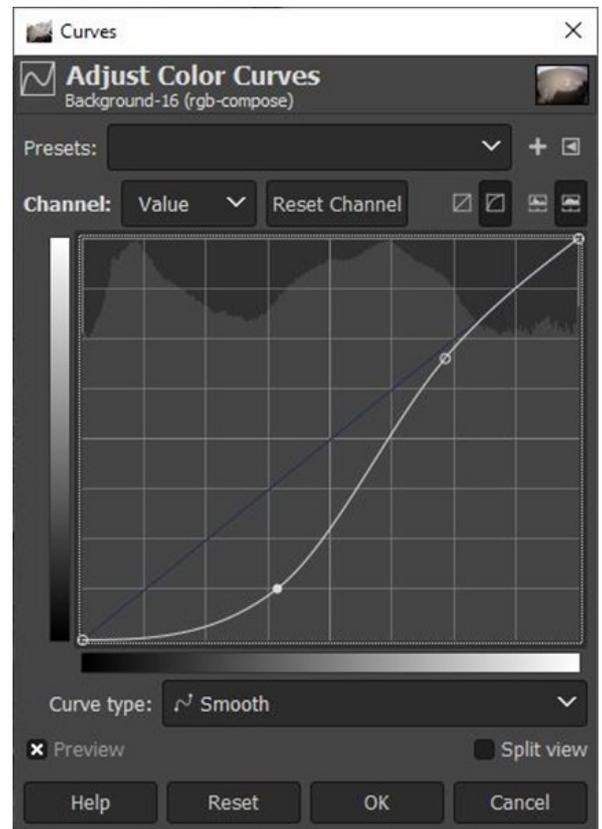


5. **Colors>Curves** can make more adjustments. The blue line running from lower left to top right shows how each different brightness pixel value is displayed. You can drag the white curve around to change how the pixels are displayed. If the darks are too bright, make them darker. If the brights are too bright, adjust them by dragging the curve around. This part is up to you and what you would like to see - explore!

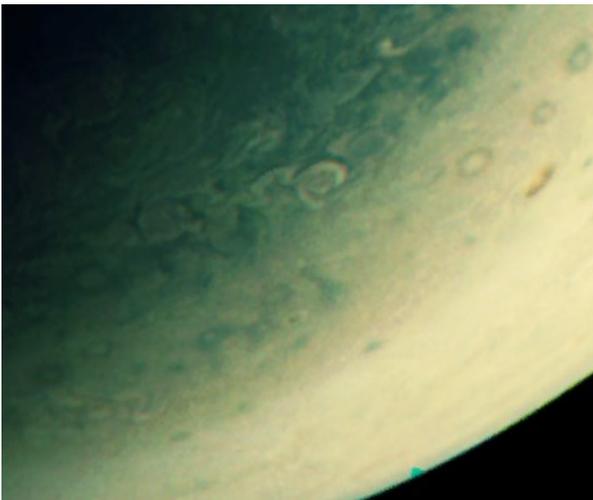
6. **Tools>Selection Tools>Rectangle Select** can be used to select part of the image. **Image>Crop to Selection** will crop the image or **Image>Fit Canvas to Selection** will preserve the full image.

7. **File>Export as** to save as a png or jpeg.

8. Admire your finished colour image.



These examples were made in GIMP from raw image files



# What can your image tell you about the planet or moon?

## Elements of Art and their Geology Matches

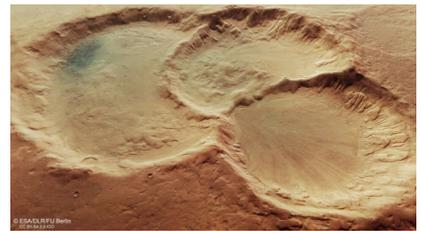
(adapted from Art and the Cosmic Connection)

What can **Shape, Line, Colour, Value or Texture** tell us about a planet or moon?

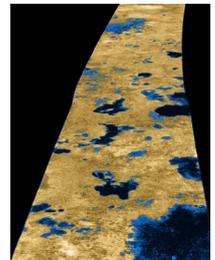
When looking at a feature ask yourself: Where else have I seen something like this? What caused it in that place? How is this similar or different? Could it be the same process at work?

### Shape: Circles, Blobs, Patterns

**Circle** – if a planet or moon has circles on it, this is usually due to craters or volcanoes. Craters can be made by impacts, which is when something else has crashed into the planet or moon. The size, shape, and number of craters can tell us what happened in the past. Sometimes circular features are volcanoes, or caused by volcanoes, like maars (which are a type of volcanic crater).



**Blobs** – uneven shapes that look like blobs might be volcanoes or lakes. The lakes might still be there (like on Titan), or the blob might show an ancient lakebed (like on Mars). Lava might have flowed from a volcano and filled in an area.



**Patterns** – patterned ground found on Earth is linked to freeze-thaw cycles. Similar patterns can be seen on Mars.

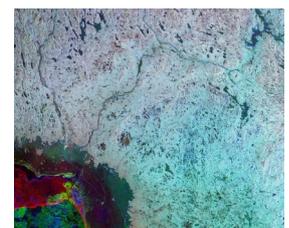


### Line: Straight or Squiggly

**Straight Lines** are linked to tectonic activity (the movement of the crust of the planet or moon) and can show us faults, ridges, cracks and mountains. On Earth, tectonic activity is related to large plates of the Earth's crust that move and slide; it can also be present in icy worlds.



**Squiggly Lines** might show us changes in the surface related to erosion. We might be looking at a place where liquid (water, lava, or methane) or air is flowing (or where it flowed in the past). Some scarps (cliffs) on Mercury are curvy, they are thought to be “wrinkles” from the surface of Mercury shrinking.



**Colour** can be related to the actual material that makes up the surface of a planet or moon (like the clouds of Jupiter). Images can use “false colour” to exaggerate colour differences or to emphasise a certain feature to make it clearer.



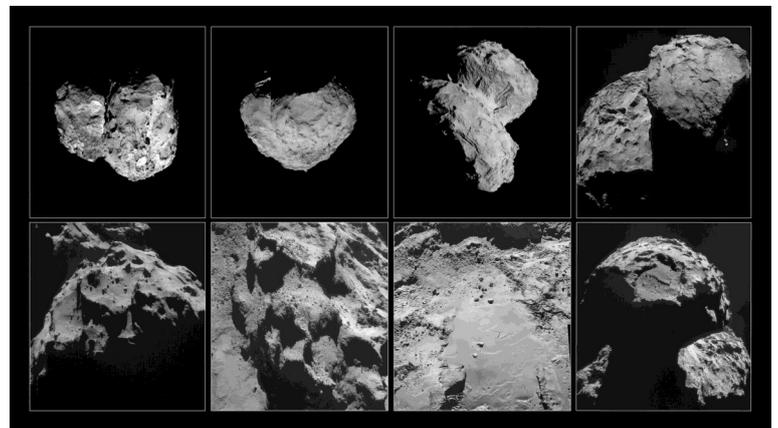
**Value: The lightness or darkness of colours.**

This is the contrast of light and dark. In science this is called albedo, the measure of how much light is reflected from a surface. It can be related to the actual material of the surface (think of snow vs. charcoal - which reflects more light?) and changes if the material is solid, or powdered or broken into chunks. Value can also change depending on how the surface is being lit by the Sun. Shadows can emphasise the other art elements and make them stand out.



**Texture: The way things look as if they might feel, if touched.**

The texture of a surface is made up of the other elements. A heavily textured surface might have many craters, with squiggly lines of erosion, and straight lines of faults. It often shows an older surface that has been exposed for a longer time. The most recent features will be the ones on top of the others, so this can help determine what happened first.



### Is your final image more art? Or more science?

To consider:

Art can include digital painting, you can:

- paste something in,
- use a paintbrush,
- use a healing brush to remove blemishes

Science can be a documentary image: “it looks like what my eye would see”

- BUT! some cameras can collect image data at wavelengths that humans do not see!
- Scientific image processing = repeatable image manipulation by applying maths to the image pixels
- Science image = edit non-destructively, and record the process