Tom Kerss, Royal Observatory Greenwich
tkerss@rmg.co.uk

Capturing the Moon's True Colours
(and what they mean…)

To our eyes, the Moon can take on many hues, usually due to scattering of light in the Earth's atmosphere. When the Moon is rising or setting, its image is reddened as the light passes through a relatively dense slice of air, in exactly the same way as the Sun. If the Moon passes through the Earth's shadow – a lunar eclipse – it can take on a deep red colour, but in this case, the scattering occurs before the light reaches the lunar surface, and the Moon really is red!

Most of the time however, we tend to see the Moon as varying shades of grey, but to a camera it's a different story. Cameras record colour information, just like our eyes, but with modern image processing techniques, we can manipulate the information to greatly exaggerate the incredibly subtle colour contrast on the Moon. The Moon has its own true colours, so here's a guide to finding them.

Take a photo of the Moon using any DSLR camera on its RAW setting. For best results, take multiple photos and stack them using a tool like Registax to produce an image with very little noise. A cleaner image will produce a more accurate result. This will work for the whole lunar disk, or a small section of the Moon. Just make sure you capture the photographs in colour, and in RAW format. Your resultant image may look similar to the one below.

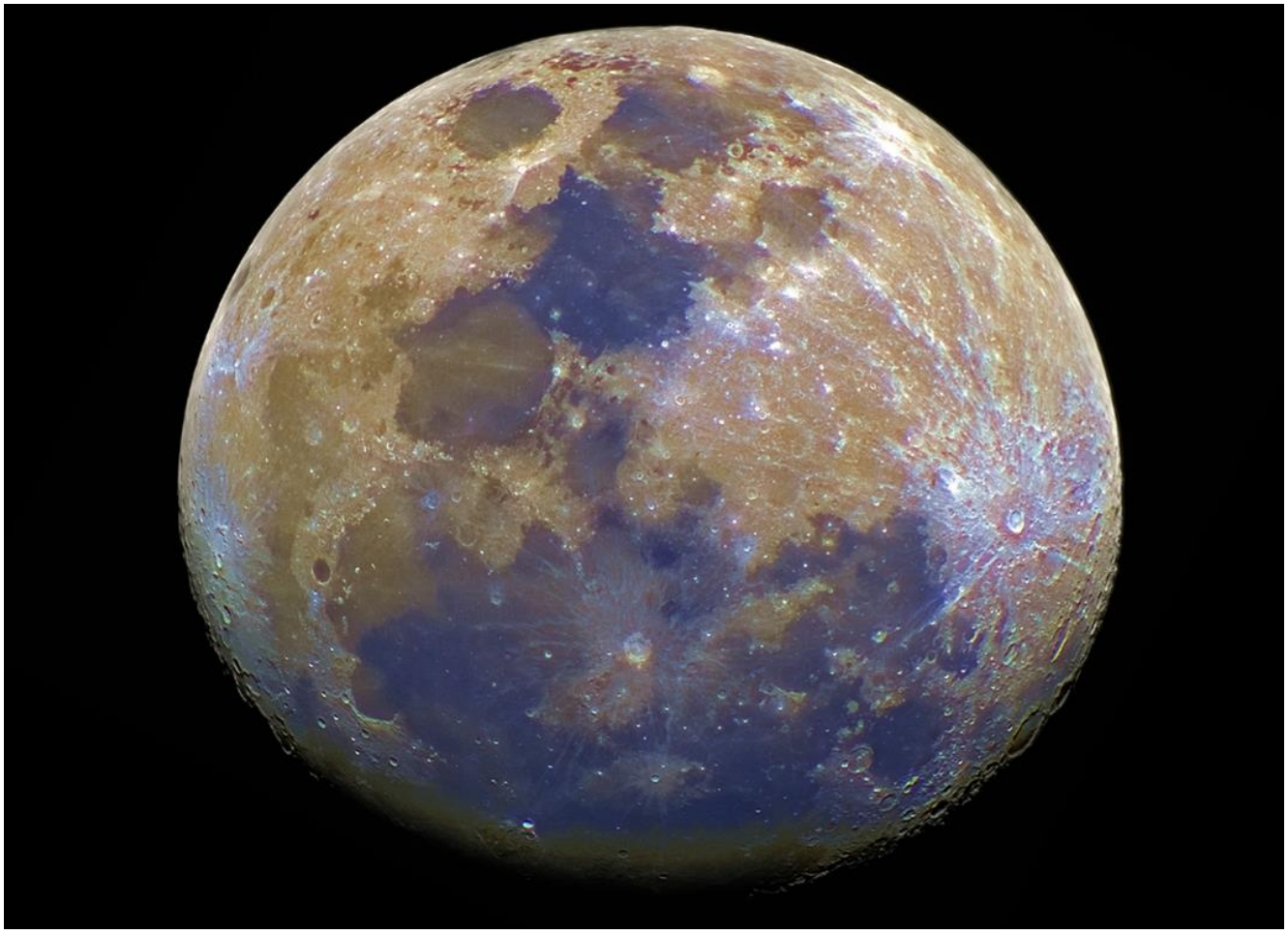
In this image, which was achieved using a small telescope, Mare Tranquillitatis (the Sea of Tranquility) has a subtle, dark blue shade. Our eyes alone would usually struggle to pick this up, but already the camera is hinting a great deal of unseen colour.

Tom Kerss, Royal Observatory Greenwich
tkerss@rmg.co.uk

RAW images contain a huge amount of digital information – much more than a JPEG. The principal advantage to shooting in RAW is the added bit-depth. RAW images are typically 16-bit, as opposed to JPEGs, which are 8-bit. An 8-bit image can store 16.8 million shades of colour, but a 16-bit image can differentiate a staggering 281 trillion (!) and therefore, shooting in RAW captures extremely subtle colour contrast that would be lost in a JPEG. All of this added information is not immediately obvious when simply looking at a RAW photo, but with image processing it can easily be accessed.

Tools like Adobe Photoshop can unlock the power of 16-bit images. Load up your photo in your image processing software, and beware that it is not downsampled to 8-bit (one popular free editor, GIMP, cannot handle 16-bit images, so all the valuable extra colour information is discarded when they're opened.)

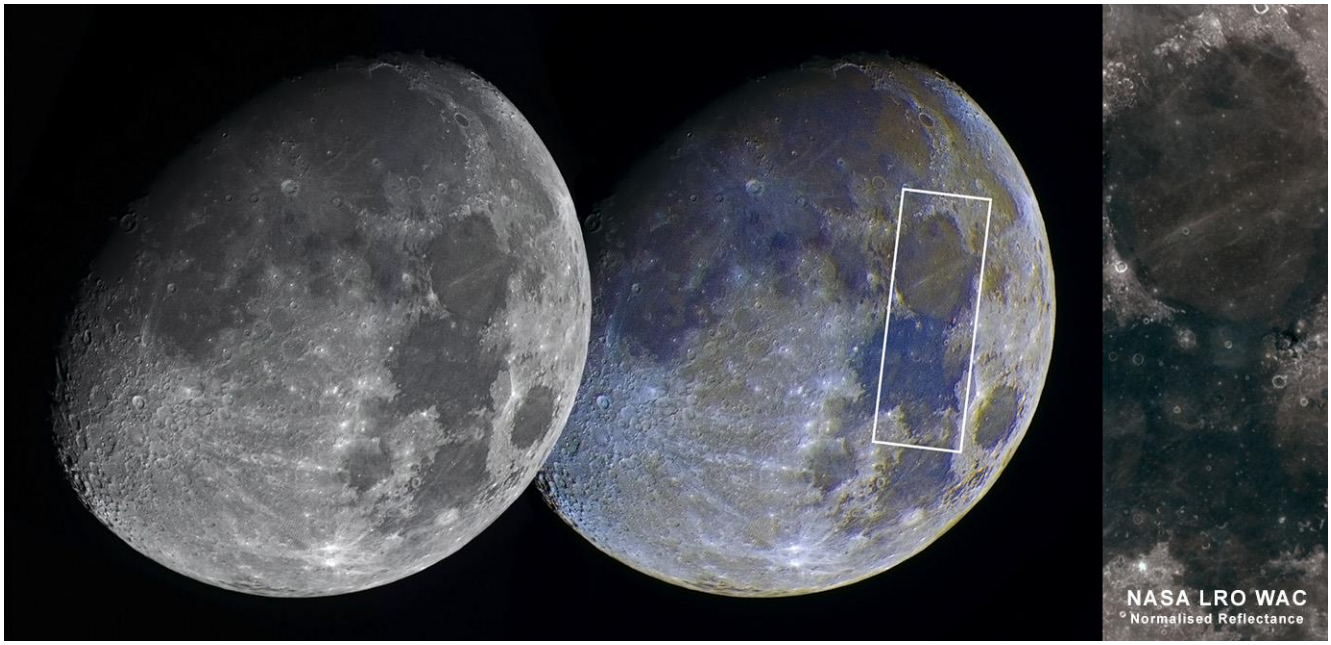
Photoshop and some of its competitors have two controls for adjusting the apparent strength of the colour; **Saturation** and **Vibrance**. Usually a good image requires a boost to both, and these can be set as adjustment layers, allowing you to easily hide them or switch between them, until you achieve a 'natural' look. Try to avoid the temptation of overdoing it, as it's possible to introduce *too much* colour, or exacerbate the false colour often present in telescope optics. The predominant colours you reveal should be blue and orange/yellow. We saw the blue in the lunar maria (seas) before, but the other shades were harder to pick out. After playing with the saturation and vibrance, you can readily achieve something that looks like this.



Suddenly, our familiar satellite has a whole new personality! Many of the flat volcanic plains are a pronounced blue colour, whereas rugged lunar highlands have a distinctive rusty appearance.

Tom Kerss, Royal Observatory Greenwich
tkerss@rmg.co.uk

Realising that this colour has always been present, albeit unseen, is one thing, and producing your own beautiful photo is another. But there's a third facet to this exercise. Astronomers have been studying the these colours for decades, and recently NASA's Lunar Reconnaissance Orbiter – the most advanced satellite ever sent to the Moon – has produced a global colour map of the surface, a small section of which is seen below (compared with another 'back garden' image.)



As it happens, these colours have great scientific value, offering clues as to the mineral composition of the lunar surface. The obvious blue tones are produced when sunlight is reflected off basalts containing relatively high concentrations (>7% w/w) of Titanium Dioxide (TiO_2). We're used to the phrase 'Blue Moon', but it turns out large areas of the lunar surface really are blue! The yellow or orange hues are a combination of terrestrial-type basalts (where the Titanium Dioxide concentration is less than 2% by weight) and a relatively high abundance of a more familiar Oxide, FeO (Iron Oxide) also known as rust. High concentrations of Iron Oxide and Titanium Dioxide render the maria darker than the highlands, due to their relatively low reflective. The rugged old highlands with their numerous impact craters have a broadly ferrous appearance, with brighter near-white streaks where relatively fresh material from more recent impacts has settled on top of the soil below.

To get better results, make sure to increase the signal-to-noise ratio of your image by stacking multiple exposures. The resultant image can be processed as two layers. Make the bottom layer grey-scale and adjust its contrast and sharpness to bring out detail in the lunar surface. Use the top layer to emphasise colours, and set its blending mode to 'Colour'. In this way, you can find a combination of fine detail and vivid colour that is most complementary to produce an aesthetically interesting result.

Have a go!