**MAPPING OF LAVA FLOWS IN OCEANUS PROCELLARUM USING CLEMENTINE MULTISPECTRAL DATA: A PROGRESS REPORT.** S. K. Dunkin[1,2], D. J. Heather[3] and I. A. Crawford[4], [1]Space Science and Technology Department, Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0QX, UK (s.k.dunkin@rl.ac.uk), [2]Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, UK, [3]Research and Scientific Support Department, ESA-ESTEC (SCI-SD), Postbus 299, 2200 AG Noordwijk ZH, The Netherlands (dheather@rssd.esa.int), [4]School of Earth Sciences, Birkbeck College, Malet Street, London, WC1E 7HX (iac@star.ucl.ac.uk).

**Introduction:** In this abstract we outline our continuing work to map the mare basalts across the lunar surface using the Clementine UVVIS dataset. Oceanus Procellarum represents the most widespread continuous deposit of mare basalts on the Moon, and an understanding of the nature of the materials within this mare is therefore of key importance to our understanding of the volcanic history and thermal evolution of the Moon. The region contains several unsampled basalts [1] so a comprehensive compositional study of all units in the region is vital if we are to fully understand the way in which lunar volcanism has shaped the Moon, and the ways in which lunar magmas and the lunar crust evolved through time.

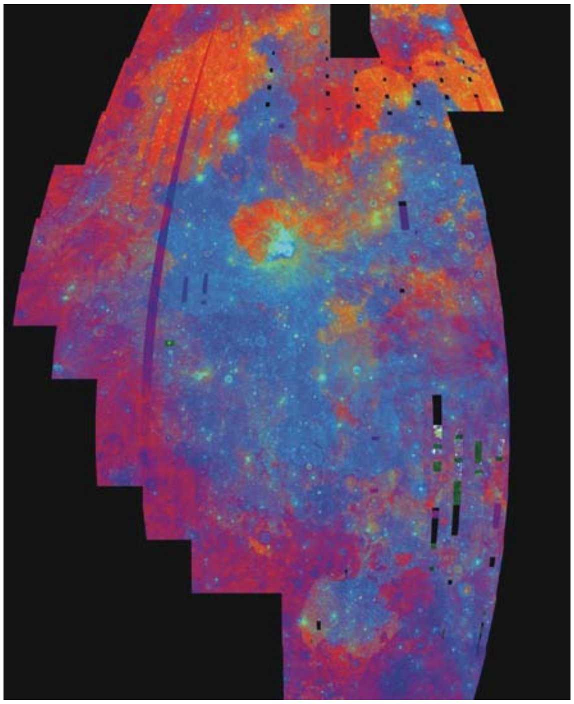
**Previous Work:** This work is part of an ongoing project in which we aim to compositionally map all basalts on the lunar surface. The southern portion of Oceanus Procellarum has already been studied as part of this project, and the results are published separately [2]. In that study the area from 17.5ºN to 20.5ºS and 289ºE to 317ºE (including the Marius Hills, Damoiseau, Cavalerius and Flamsteed areas) was covered, with a total of 13 basalts being identified, 10 of which are spectrally distinct. These basalts were placed in the stratigraphic column of [3], adding a further three to those previously recognised in the region.

In addition to the mapping of basalt flows in the region, calculations were made for upper and lower limits of their thickness. This was accomplished using the impact craters within the maria to see if they had excavated deep enough to cut through all of the basalts and expose the highland materials below. If highland materials are present, then the excavation depth of the crater must be greater than the thickness of the basalt flows, and this value therefore represents an upper thickness limit. Conversely, those craters which do not expose highland materials must not be deep enough to cut through all of the basalt flows, so their excavation depths provide lower limits for the flow thickness at that point. The average thickness of the basalts in the region of southern Oceanus Procellarum already studied is 160-625m, which equates to an estimated volume of between 0.7 and 2.8×$10^5$ $km^3$.

**This work:** This work uses the reduced five-band UVVIS dataset from the Clementine multispectral dataset. From this we constructed a "true" colour image (red channel = 950nm, green channel = 750nm, blue channel = 415nm), a standard multispectral ratio image (red = 750/415nm, green = 750/950nm, blue = 415/750nm, Figure 1), and a $TiO_2$ map constructed using the algorithm of [4] (Figure 2). All mosaics were produced with a resolution of 200 m/pixel and covered a region from 20ºS to 60ºN and from 280ºE to a maximum of 340ºE.

Mapping is currently underway for the regions immediately surrounding the southern area of Oceanus Procellarum presented in [2]. Potential compositional boundaries are first mapped from the multispectral and $TiO_2$ mosaics. The spectral character of a mature basalt in the Clementine data is primarily governed by its UV/VIS ratio, which is empirically related to the abundance of titanium in the soil [5,4]. Variations in the Clementine multispectral ratio image will therefore tend to correlate with changes in composition, as long as the soils are of a similar maturity. Once the first-order boundaries are located, quantitative techniques are used to confirm that they represent true compositional variations. Boundaries which may have external influences such as slope effects or the deposition of fresh ejecta from craters, are removed during this part of the analyses, as are those boundaries that show only weak variations in UV/VIS slope or in the strength of the iron absorption band in the 1 μm region. The techniques used are described more fully in [2] and [6]. Once the mapping of these blocks is complete, they will be linked together with the area already studied to provide a more regional context.

The final boundaries will identify units to be placed in the Oceanus Procellarum stratigraphic column developed by [3], adding newly identified units where necessary and using a combination of photographic (Lunar Orbiter / Apollo) and multispectral datasets to correctly place the units in their stratigraphic sequence. This work will provide the first high *spatial* resolution compositional map of the Oceanus Procellarum region, complementing the early higher



spectral resolution work carried out using ground based observations [1].

**Figure 1: A standard multispectral ratio image of the Oceanus Procellarum region. See text for details of the ratios used to construct this image.**

*Basalt thickness:* In addition to the mapping work, an estimate of the upper and lower limits for basalt thickness and hence volume of lava erupted will be made using the impact craters as a depth indicator. Clementine provides the first opportunity to carry out such work on small craters due to its high spatial resolution. This method was successfully used in [2] and will be compared to those estimates from [7,8,9] to provide a mean estimate of the volume of basalts in Oceanus Procellarum.

**Future Work:** Within Oceanus Procellarum are a number of volcanic complexes, including Marius Hills, the Rumker Hills and the Gruithuisen domes. The latter two provinces will be investigated thoroughly during the mapping of their block, as they have special significance to the volcanic history of the maria. The Marius Hills region has already been investigated and a flow map including detailed analyses of its volcanic history has been published separately [10]. The peculiarities of these regions in combination with the results of the mapping project within Oceanus Procellarum will help us better understand the mechanisms by which lunar magmas are generated, and rise through an evolving crust to erupt onto the surface. Such studies of the surface expression of lunar magmatism are one of the few ways of constraining theories for the thermal evolution of the Moon, such as that recently advanced by [11].

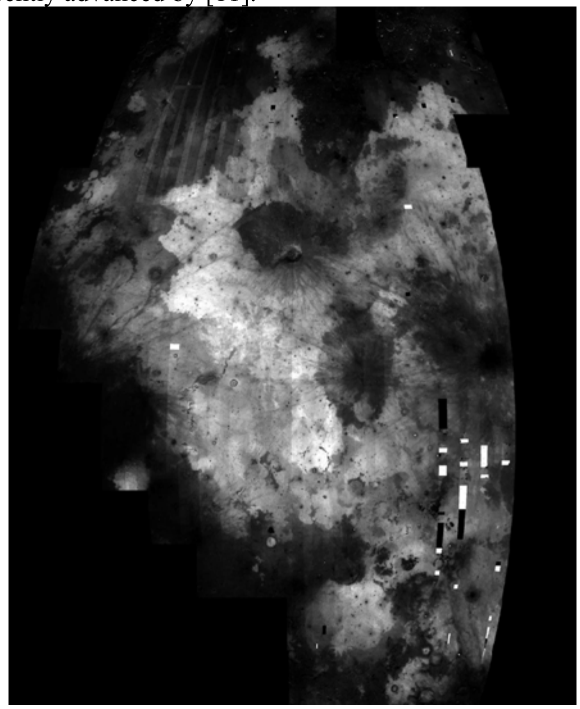


**Figure 2: A TiO2 image of the Oceanus Procellarum region, created using the algorithm of [4].**

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