LUNAR CRUSTAL COMPOSITION IN THE HUMBOLDT CRATER REGION. M. Martinot[1,2], J. Flahaut[3], S. Besse[4], C. Quantin[2], W. van Westrenen[1], K.L. Donaldson Hanna[5] and J.F. Blanchette-Guertin[6], [1]Vrije Universiteit Amsterdam, 1081HV Amsterdam, The Netherlands, email: m.martinot@vu.nl, [2]LGL-TPE University of Lyon, 69622 Villeurbanne cedex, France, [3]IRAP Université Paul Sabatier, 31400 Toulouse, France, [4]ESAC, 28691 Villanueva de la Canada, Madrid, Spain, [5]University of Oxford, Oxford OX1 3PU, United Kingdom, [6]IPGP, 75013 Paris, France

Introduction: The lunar crustal composition and stratigraphy provide insight into the understanding of the thermal and magmatic evolution of the Moon *e.g.*, [1]. Spectroscopic datasets have been used to survey the mineralogy of the lunar surface and provide constraints on the crustal composition. Some authors proposed that the mafic content of the crust increases with depth, *e.g.*, [2]. Others suggest that the crust becomes more plagioclase-rich as it thickens, and more mafic-rich as it thins [3]. This study aims at characterising the mineralogy of the crust-mantle transition zone with spectroscopic data from the Moon Mineralogy Mapper (M³) and imagery from the Lunar Reconnaissance Orbiter and Kaguya cameras available over the central uplift of selected craters in the Humboldt region of the Moon.

Datasets: Mineralogical information is derived from M³ data. M³ is a visible to near-infrared hyperspectral imager, with 85 spectral channels spanning from 430 to 3000 nm [4] and a spatial resolution of up of 140 to 280 m/pixel. High-resolution images of the craters are provided by the Lunar Reconnaissance Orbiter Wide Angle Camera (WAC, resolution of 100 m/pixel) and Kaguya Terrain Camera (TC, resolution of 10 m/pixel) mosaics.

Crustal thickness values are estimated from Gravity Recovery and Interior Laboratory (GRAIL) crustal thickness model 1, derived from gravimetric data of the GRAIL mission [5]. Combined with cratering equations, pre-impact crustal thickness estimates are used to calculate the proximity to the mantle for numerous craters. The depth of origin of the material emplaced in the craters central uplift is calculated using the melting depth as a minimum depth of origin of craters central uplift material [6]. The proximity value to the crust-mantle transition zone (P, or distance to the mantle) is calculated by subtracting the melting depth to the crustal thickness. If the proximity value is positive, then the crater central uplift sampled crustal material; if the proximity value is negative, mantle material may be uplifted in the central uplift [7].

The choice of Humboldt crater: [8] studied the distribution of pure crystalline plagioclase in the lunar crust. Figure 1 shows the proximity value of the craters displaying plagioclase in their central uplift [8]. While most craters display a positive proximity value, two craters, Humboldt and Zeeman craters, have a negative proximity value (their central uplift contains plagioclase-rich rocks, whereas they should sample material originating below the crust/mantle transition zone).

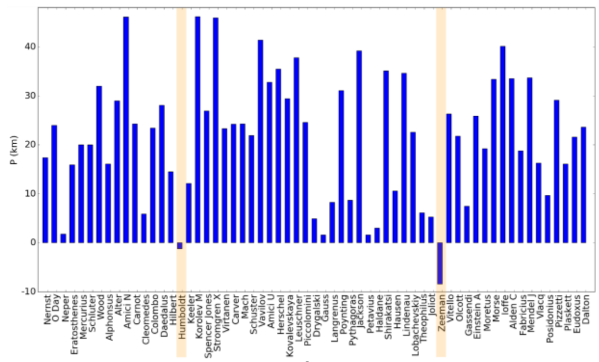

Figure 1: Proximity value of the craters exhibiting plagioclase in their central uplift (from [8]). The proximity value is calculated with crustal thickness estimates derived from GRAIL model 1 [13]. A negative proximity value (Humboldt and Zeeman craters, highlighted) means that mantle material should be sampled in the crater's central uplift.

Zeeman crater is a 184 km diameter crater located within the South-Pole Aitken (SPA) basin, which is believed to have differentiated after formation [9]. The interpretation of the mineralogy encountered in the central uplift of Zeeman crater would be contaminated by SPA impact melt sheet differentiation, which is why Zeeman crater is discarded from further study. Humboldt crater is a 205 km diameter complex crater, located in the highlands and is selected for further investigation.

Surveying the Humboldt crater region: The Humboldt crater floor displays concentric and radial fractures [10], and four pyroclastic deposits, two of which are associated with a mare pond [11]. The volcanic deposits are highlighted in yellow and green in the colour composite presented in Figure 2. The yellow stars show the pure crystalline plagioclase occurrences described by [8]. The central uplift is largely dominated by plagioclase, compatible with a crustal signature. Interestingly, spinel and olivine are detected in Humboldt crater's walls, suggesting they originate at a shallow depth. In order to determine if the plagioclase signature of the Humboldt crater central uplift is a regional trend, two additional craters are studied in the vicinity of Humboldt crater. Petavius crater is a 188 km floor-fractured crater located on the nearside of the Moon. Its proximity value is small but positive

(+1.63 km). [8] described pure crystalline plagioclase occurrences on Petavius crater central uplift (Figure 3.a), compatible with a crustal signature. Milne basin is a 272 km diameter peak ring basin located on the far-side of the Moon. Milne basin proximity value is negative (–12.15 km). [8] described several occurrences of pure crystalline plagioclase on the basin floor (Figure 3.b). The colour composite Figure 3.b highlights pyroxenes in yellow, green and reddish patches according to the respective size of the absorption bands area. Milne peak ring has a mafic, pyroxene-rich signature, which might be compatible with a lower crust or mantle signature [12].

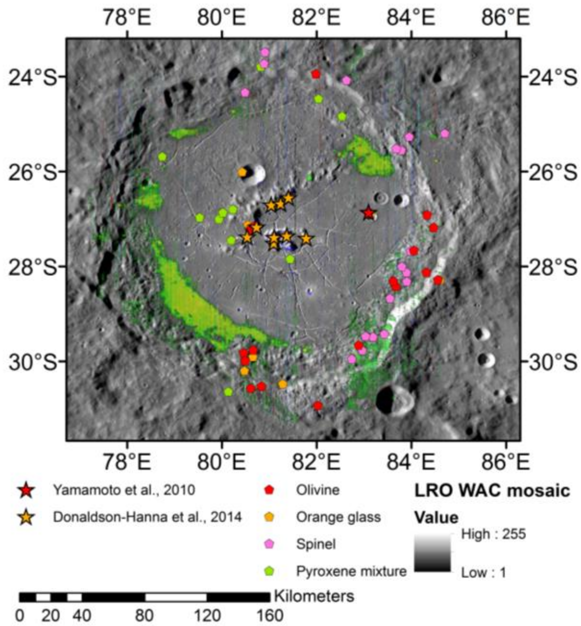

Figure 2: Humboldt crater colour composite of M³ spectral parameters (R = area of the 1 µm band; G = area of the 2 µm band; B = 1 µm band centre) overlaid on LROC WAC mosaic. The pure crystalline plagioclase detections of [8] are denoted by the yellow stars, and the olivine detection by [14] is denoted by the red star. This study's mineralogical detections are reported as pentagons.

Conclusions: Humboldt and Petavius craters have small proximity values (–1.23 km and +1.63 km, respectively), meaning that their central uplift could contain mantle material. However, a strong plagioclase signature is observed on their central uplift, compatible with a crustal signature. Milne basin peak ring has a lower proximity value (–12.15 km) and a more mafic signature that might be compatible with a lower crust to mantle signature. The strong plagioclase signature of Humboldt and Petavius craters central uplift, combined with their small proximity value, could mean that the crust in the Humboldt crater region is thicker than predicted by GRAIL model 1. Alternatively, Humboldt and Petavius craters central uplift might sample a plagioclase-rich pluton emplaced in the lower crust.

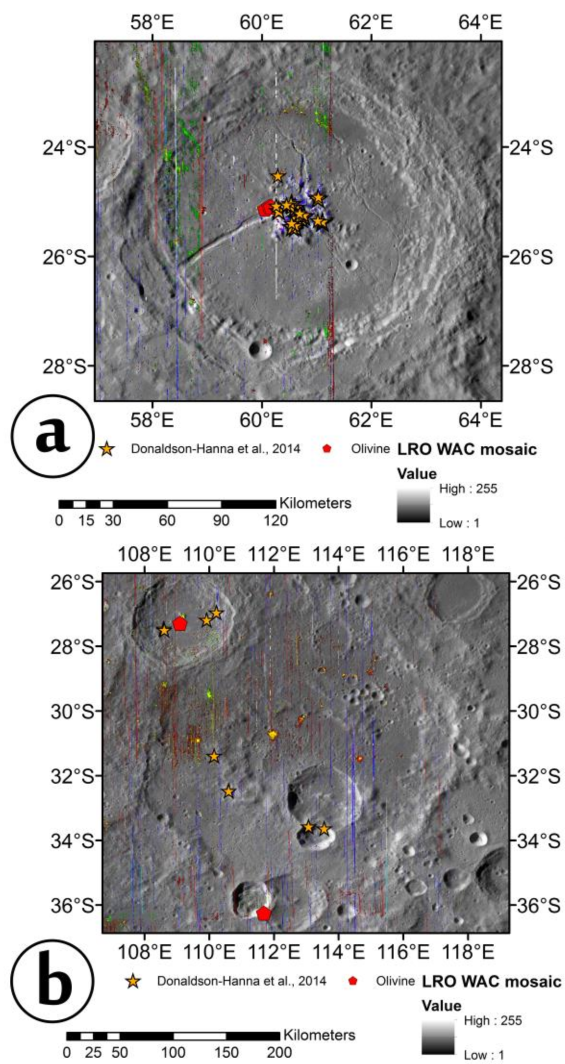

Figure 3: Petavius (a) and Milne (b) craters colour composites of the M³ spectral parameters (R = area of the 1 µm band; G = area of the 2 µm band; B = 1 µm band centre) overlaid on LROC WAC mosaic. The pure crystalline plagioclase detections of [8] are denoted by the yellow stars. This study's mineralogical detections are reported as pentagons.

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