NEW GEOLOGIC MAP OF THE LUNAR CRISIUM BASIN M. U. Sliz[1,2], and P. D. Spudis[2], [1]School of Earth, Atmospheric and Environmental Sciences, the University of Manchester, Oxford Road, Manchester, United Kingdom, M13 9PL; malgorzata.sliz@student.manchester.ac.uk, [2]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058.

Introduction: Crisium is a multi-ring impact basin of Nectarian-age, located in the northeastern portion of the lunar near-side [1]. The basin is morphologically complex, suggesting that the basin was subjected to post-formation modification. Moreover, Crisium's radial extent has been a subject of disputes which concluded that the basin extends as far as a 1000 km in diameter. The geology of Crisium has been studied previously [2, 3] with aims of characterizing the basin's composition and formation process. The images from the Lunar Reconnaissance Orbiter and Clementine missions permit new detailed study and mapping of this region.

The aim of this project was to map the highland surrounding the Crisium basin, with focus on creating a basin-centered geological map of its deposits. The remote sensing data used in completing the project included the Lunar Reconnaissance Orbiter (LRO) imagery, the Clementine maps of Fe and Ti, and LOLA topographic maps. The new geological map of Crisium was used to study the composition and origin of the basin deposits which both can help to make inferences about the composition of the basin's crustal target. Moreover, the study of Crisium's origin can contribute to the understanding of the processes behind formation of multi-ring impact basins on the Moon.

Method: The LRO Wide Angle Camera (WAC) map with resolution of 100 m/pixel was used as the base for the geological map. The base map was converted into a basin-centered projection and geological units were added on top the map in a series of layers using the ArcGIS ArcMap 10.1. Clementine

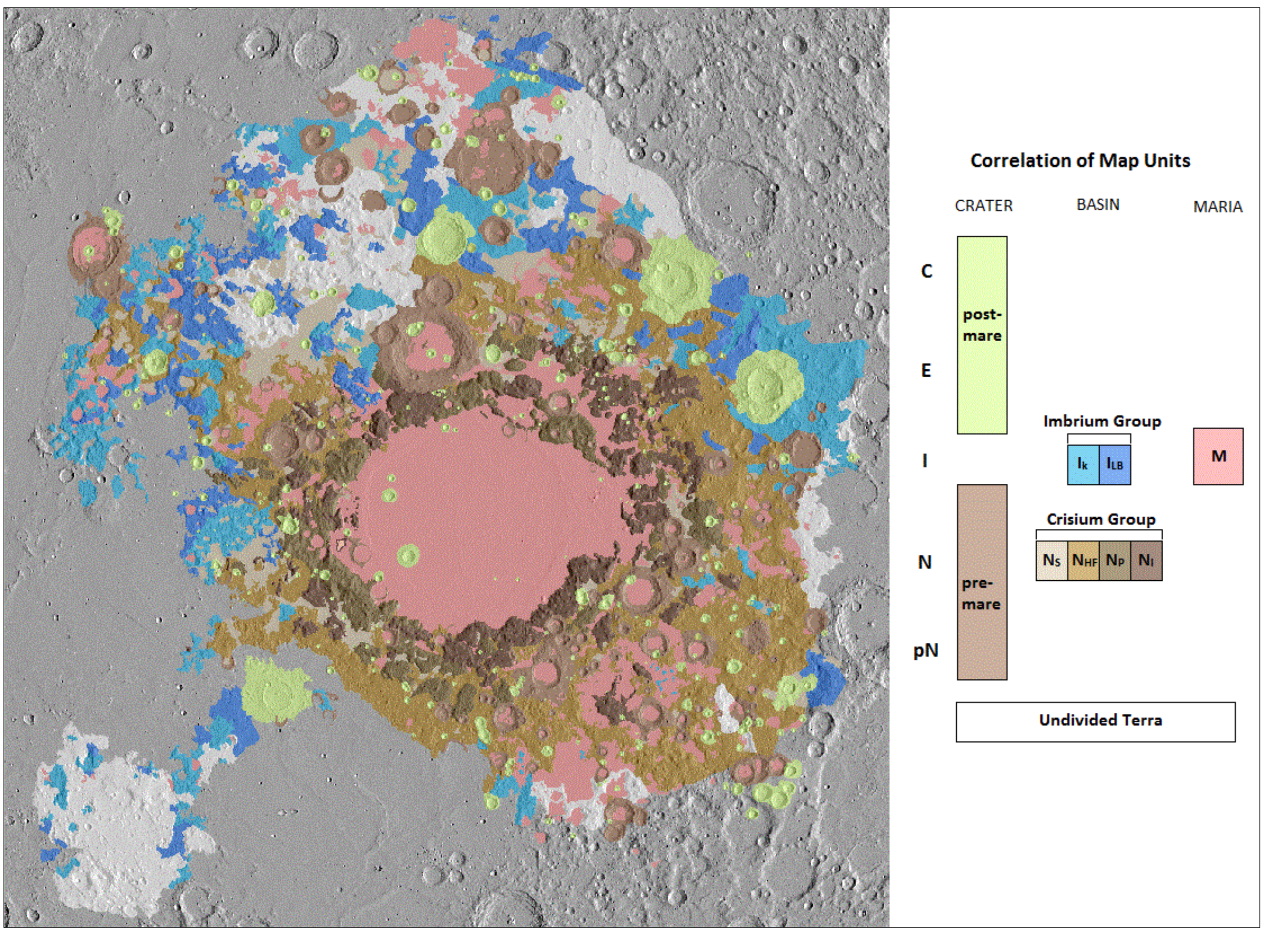

Figure 1. New geological map of the Crisium impact basin. The area shown is 1700 by 1750 km in size.

FeO and TiO_2, and Lunar Prospector Th concentration maps, Clementine RGB false color map, as well as LOLA shaded relief and topography maps were used to aid the mapping of the Crisium basin units. The shaded relief and topography maps were especially useful in cases of units where unit boundaries were not clearly visible on the base map, and to distinguish between units with similar characteristics, e.g. platform and irregular massifs. Ten separate units were defined on the basis of surface texture, morphology, chemical composition, stratigraphic position and location within the basin.

The geological map was subsequently employed in geochemical analysis which involved obtaining zonal statistics of each unit for elemental concentrations using Spatial Analyst tool in ArcGIS.

Results: Ten units were distinguished as basin deposits on the new geological map of the Crisium basin. In stratigraphic order from oldest to youngest, the units are: Undivided Terra, Pre-mare Crater Material, Irregular Massifs, Platform Massifs, Smooth Plains, Hilly and Furrowed Terrain, Mare Basalts, Lineated Basin Material, Knobby Material, and Post-mare Crater Material (Figure 1).

The Crisium Group comprises four members: Irregular Massifs, Platform Massifs, Smooth Plains, and Hilly and Furrowed Terrain. All are of Nectarian-age. The Irregular Massifs concentrate around the central mare within an approx. 460 km radius from the basin's center. The unit appears blocky with irregular peaks, and is topographically higher than majority of the surrounding terrain. Platform Massifs are similar to the Irregular Massifs in their blocky structure; however these massifs appear to have flat tops, similar to terrestrial mesas. Hilly and Furrowed Terrain extends up to 750 km radially from the center of the Crisium basin, and stands as a transition unit between the low-lying, flat Mare Basalts and the massif units.

The Imbrium Group consists of material related to that distant (~1200 km) basin and displays two members: Knobby Material and Lineated Basin Material. These lie beyond the second ring of Crisium at approx. 385 km radius, and occupy predominantly the north-western portion of the basin. The Knobby Material has hummocky structure and comprises of irregularly shaped blocks. The Lineated Basin Material shows striae radial (NW-SE) to the Imbrium structure and can also appear hummocky in places. One segment in the south-eastern portion of the Crisium basin shows an emplacement direction of NE-SW.

The craters in the Crisium basin were subdivided into two members: Pre- and Post-mare Crater Material. Pre-mare craters were classified as pre-Nectarian to early Imbrian and are heavily modified, with majority possessing smooth, mare-infilled floors. Post-mare craters are of late Imbrian, Erasthotenian to Copernican age. These craters have well-developed rims, some still possess rays (e.g., Proclus).

Crisium ejecta is feldspathic in composition, with no clinopyroxene evident in the Clementine false-color composite. The south-eastern portion of the Hilly and Furrowed Terrain displays a wide range of FeO concentrations (4.29-16.82 wt%) which may result in part from ‘contamination' of the deposit by mare basalts of Mare Undarum and Mare Spumans.

In western Mare Crisium near Yerkes crater is a system of fractures. Although initially suspected to be a mare intrusion (laccolith), Clementine color and chemical composition data show that this feature is of highlands, not mare, composition. The feature has low FeO (8.5%), Th (0.26 ppm) and TiO_2 (0.61 wt%). Cracked and fissured deposits on basin floors are typified by the Orientale basin Maunder Formation, interpreted to be the remnant of the basin impact melt sheet [4]. We similarly interpret this feature as a remnant of the Crisium basin melt sheet [5]. This deposit should be considered a high priority target for future lunar sample-return missions because it would enable accurate dating of the Crisium impact event, as well as determining the composition of the basin's crustal target. Similar features are also found elsewhere inside the Crisium basin.

Conclusion: An updated geological map of the Crisium Basin co-registered with element concentration maps allow compositional studies of the mapped units. Two groups of units were distinguished - the Crisium Group and the Imbrium Group. The Imbrium Group was interpreted as ejecta from the Imbrium basin. The composition of Crisium ejecta is feldspathic, with mean FeO between 6-10 wt.% We have identified possible melt sheet remnants within the Mare Crisium; these deposits should be candidates for future sample-return missions.

References: [1] Spudis P. D. (1993) *Geology of Multi-Ring Impact Basins* Cambridge Univ. [2] Wilhelms D.E. (1987) USGS PP 1347 [3] Wilhelms and McCauley (1971) USGS Map I-703. [4] Spudis P. D. et al. (2014) JGR **119**, E004521. [5] Spudis P.D. and Sliz M. (2016) this volume.