REMOTE SENSING AND GEOLOGIC STUDIES OF MARE AUSTRALE: THE NORTH AUSTRALE REGION. S. J. Lawrence[1], J. D. Stopar[2], L. R. Ostrach[3], C. H. van der Bogert[4], H. Hiesinger[4], B. L. Jolliff[5], T. A. Giguere[6], H. Sato[7], and M. S. Robinson[7]. [1]NASA Lyndon B. Johnson Space Center, Houston, TX, USA (samuel.j.lawrence@nasa.gov) [2]Lunar and Planetary Institute, Houston, TX, USA [3]Astrogeology Science Center, United States Geological Survey, Flagstaff, AZ, USA [4]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Germany [5]Washington University in St. Louis, St. Louis, MO, USA [6]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI, USA [7]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA

Introduction: A key goal of the Lunar Reconnaissance Orbiter (LRO) mission is to investigate volcanic processes at different temporal and physical scales, with one emphasis being the characterization of ancient (meaning, > 3.9 Ga) volcanic units. One such ancient volcanic terrain is Mare Australe, a loosely-circular collection of mare basalts centered at approximately 38.9º S, 93° E (Fig. 1). Mare Australe is a complex, extensive, and poorly understood volcanic region [1-6]

Background: There have been several previous studies of Australe using legacy data sets. [1] postulated four periods of Nectarian to Erastosthenian based on geologic mapping. [7] determined absolute model ages for some of the basalt units in the Australe region ranging from 3.08-3.91 Ga. There have been proposals that Mare Australe is a pre-Nectarian impact basin [3, 8-10] but there is no well-defined basin rim boundary [11]. Fundamental information about the stages of mare formation processes are preserved in the discrete Australe basalt deposits, which potentially represent one or several disconnected eruptive events and basin-forming impacts, such as the northern Australe basin.

Goals: The goals of our study are to 1) identify and characterize the discrete basalt deposits in the Australe region using new LRO data products 2) identify possible basaltic source vents and 3) further characterize mare stratigraphy and evolution of mare sources in the region. Previously, we reported preliminary work using new LRO data to understand the distribution of volcanic landforms and the extent of mare basalt exposures in the Australe region, as well as the geochemical properties of the basalt units as a function of absolute model age and the relationship between model age and surface roughness at the scale of the Narrow Angle Cameras.

Recent GRAIL results [12] indicate that an ancient impact basin exists in the northern part of Australe, so here, we synthesize the results of our previous investigations to study the properties of the mare basalt deposit associated with the proposed north Australe basin in more detail.

Methods: This study uses observations and data products from LRO, particularly the LRO Wide Angle Camera (WAC). The WAC is a push-frame camera capturing seven color bands (321, 360, 415, 566, 604, 643, 689 nm) with a 57-km swath width in color mode and a 105-km swath width in monochrome mode from a 50-km altitude [13]. Primary data products employed in this investigation include the WAC global morphology base map, the GLD100 global topography dataset [14], and the Hapke parameter photometrically corrected WAC color dataset of [15]. The GLD100 (spatial resolution sampling of 100 m and a vertical accuracy of 10m) is being used for all topographic measurements. The GLD100 was used to compute the Terrain Ruggedness Index (TRI), the mean elevation difference between the central DTM pixel and its surrounding cells, at a pixel scale of 100 m [16].

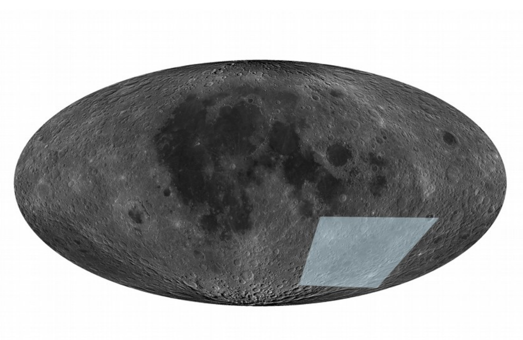

Fig. 1: Location of Mare Australe and associated study region.

New crater size frequency distributions (CSFDs) for 88 surface units in the Australe region were collected and used to determine absolute model ages (AMAs) following the methods of [7], applied to the WAC morphology base map (e.g., Fig. 2). All craters larger than 1 km in diameter identified in the LROC WAC global morphology base map were included in the counts.

Individual landforms in the Australe region are being assessed using LRO Narrow Angle Camera (NAC) monoscopic observations. NAC Digital Terrain Models with pixel scales of 2 – 5 m were used to investigate the topography and surface roughness characteristics of individual mare and highland units in the region.

Finally, we used legacy datasets, including Clementine FeO and TiO_2 maps of the Australe region produced using the techniques of [17], controlled to the WAC morphology basemap, and Th abundances extracted from the reduced half-degree Th dataset collected during the low-altitude portion of the Lunar Prospector mission [18], to characterize the composition of individual units. The boundaries of each deposit were based on those from [7], and refined using the WAC color data of [15]. Taken collectively, these data products enable us to analyze the physical parameters and compositions of Australe units as a function of age.

Results: The proposed basin revealed by GRAIL is located at 35.5ºS, 96ºE (Fig. 2). This correlates to a discontinuous grouping of mare basalts in the north part of Mare Australe. In general, the basalt units associated with the gravity anomaly are similar to the other basalt exposures in the Australe region and are observed to have the following characteristics:

(1) The North Australe basalts have model ages that range from 3.46-3.63 Ga. These AMAs are some of the youngest model ages reported in Mare Australe, but are nevertheless within the model age range for all of the other basalt units in Mare Australe (Fig. 3);

(2) Similarly, the average equipotential surface height is largely similar to the elevations of other Australe basalts; the North Australe basalts have an average elevation of -1900m, which is within the observed range of -226 to -4596 meters; and

(3) The Th contents for the North Australe region range from 1.8-2.1 ppm Th, which is also within the observed range of 1.2-2.2 ppm Th.

Implications: Our previous results [19] suggested that the geochemistry of the Australe basalts did not appreciably change as a function of modeled eruption age. The youngest basalt exposures in the Australe region have model ages between 3.2-3.4 Ga, and these exposures have variable geochemical properties and are scattered throughout the Mare Australe region in no discernable geographic pattern.

While there is only unambiguous evidence for the North Australe basin, the quasi-circular pattern of basalt emplacement suggests that the thinner crust in the Australe region and associated mare basalts are a product of an even larger, older impact basin, subsequently obscured by processes such as isostatic rebound. Thus, the possibility exists that Australe is at least as old as South Pole-Aitken, although this possibility will require sample return for a definitive assessment.

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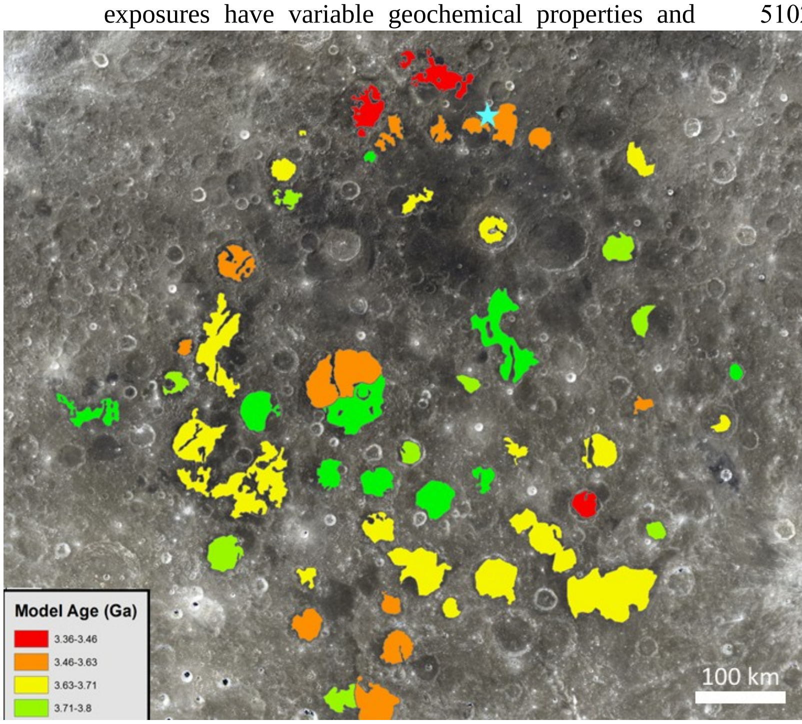

Fig. 2 (left): Absolute model ages for Mare Australe, overlain on WAC color; blue star is location of of North Australe basin centroid.

Fig. 3 (below): Absolute model ages for basalt units in North Australe (red) compared to rest of Australe (blue).