CONTRIBUTION OF THE LUNAR BASIN EJECTA TO MATERIALS WITHIN THE LUNA-GLOB LANDING ZONE.

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Introduction: Landing zone of the Russian Luna-Glob (LG) mission is near the southern portion of the rim of the South Pole-Aitken (SPA) basin [1,2]. This structure and the other lunar basins are the main sources of materials that form the megaregolith [3,4] in the landing zone where the ancient terrains of pre-Nectarian and Nectarian ages absolutely dominate [1]. The stratigraphic units that compose the pre-Nectarian terrains are mostly related to the emplacement of the SPA ejecta. However, ejecta of the post-SPA basins, which transported materials to large distances [5-8], also can participate in the formation of regolith on the LG landing zone. In order to facilitate interpretation of the results of the LG in-situ analyses, it is important to assess the potential contribution of ejecta of the lunar basins to the materials that may be encountered in the landing zone.

Models of the ejecta thickness radial variations: A range of models of the material transport and ejecta emplacement have been developed in the past [9-16] (Fig. 1). Among these, only the model by [15] is supported by the observations of topography associated with the best preserved lunar basin, Orientale. The application of this model, however, is limited by the estimated ejecta thickness at the Cordillera rim. For the other basins, this thickness can be different and, thus, the estimates of the ejecta radial thickness can be biased. Because of this limitation, in our study we used the theoretical model by [13], which relates the ejecta thickness, T, and the distance from the impact point, r, by the following formula: $T=0.0078*R*(r/R)^{-2.61}$, where R is the radius of the crater transient cavity. It must be emphasized that all models of the ejecta emplacement do not account for the separation of the ejecta curtain into individual rays and consider the emplaced ejecta as a contiguous blanket. This obviously erroneous assumption shifts the model thickness values up and tends to overestimate the thickness of the ejecta.

Model thickness of the basin ejecta in the LG landing zone: In order to assess the possible amount of materials from different major remote sources within the landing zone, we used the approach developed in [17]. Specifically, we constructed a 1x1° grid for the southern sub-polar region (southward of 60°S) and in each point of the grid we calculated the thickness of materials ejected by each lunar basin [18]. In order to estimate the basin ejecta thickness, we implemented the model developed in [13].

An important part of the investigations of the variation of the basin ejecta thickness [17-20] was an assessment of the mixing ratio [12] of local and remote materials brought by large impacts. This parameter helps to estimate the depth to which the ejecta affect the original material upon their emplacement. The mixing ratio is poorly constrained and its usage sometimes gives unrealistic results. For example, attempts to estimate the depth of mixing in the case of the SPA basin yield values of the mixing depth as large as ~50 km. Such a depth is about six times larger than the estimated thickness of the basin ejecta. Thus, in our work, we did not employ the mixing ratio to determine the depth of mixing and simply calculate the fraction of the brought materials based on their model thicknesses. We also grouped the basins by their stratigraphic position [4] and estimate fractions of materials delivered to the Luna-Glob landing zone by the SPA basin and by the pre-Nectarian, Nectarian, and Imbrian basins separately.

Results and discussion: The results of our model show the following. As expected, the major contributor of materials to the LG landing zone is the SPA basin (Fig. 2). Near the rim of the basin transient cavity, the thickness of the ejecta is estimated to be ~8.1 km.

However, because the model thickness follows a power law, it rapidly decreases away from the basin rim. For example, the model thickness of the SPA ejecta at the southeast corner of the LG landing zone (the closest to the SPA) is ~5.5 km. For the most distant, northwest, corner of the LG landing zone the model thickness is ~1.8 km. The mean model thickness of the SPA ejecta within the Luna-Glob area is ~3.2 km, which is ~96% of the total thickness of ejecta of all lunar basins in this region. We assume that the SPA basin is the oldest lunar basin and, thus, its ejecta form the base of the stratigraphy of the basin ejecta in the study area.

All the pre-Nectarian basins have added a small fraction, ~3.6%, to the total thickness of the basin ejecta within the LG landing zone. Among these basins, Australe (Fig. 2) appears as the most important source of materials. The model ejecta blanket of Australe overlays the eastern side of the landing zone where its thickness can be ~130-150 m. Within the landing zone, the mean model thickness of the Australe ejecta is ~70 m. The mean model thickness of the ejecta of the other pre-Nectarian basins in the landing zone is a few meters or less.

Both the Nectarian and Imbrian basins (Fig. 2) have delivered a negligible amount (a few tens of meters) of materials to the Luna-Glob landing region compared with the thickness of the SPA ejecta (several kilometers). Among the Nectarian basins, the most important sources of the remote materials in the LG zone are Serenitatis and Nectaris. Despite the fact that the Imbrian Schrödinger basin is the closest to the landing zone, the mean model thickness of its ejecta is estimated to be less than one meter and the main

Imbrian source of foreign material in the landing zone is the Imbrium basin itself.

In the framework of the no-mixing model, ejecta of the post-SPA basins form the upper portion of the composite layer of ejecta of the basins in the landing zone. The crater gardening, however, locally would tend to change the regional stratigraphy of the basin ejecta and an analysis of local geology is needed in order to estimate the most probable sources of material at each specific landing site.

Acknowledgements: The work was supported by the DFG grant HI 1410\12-1 and the RSF grant № 17-17-01149 to MAI.

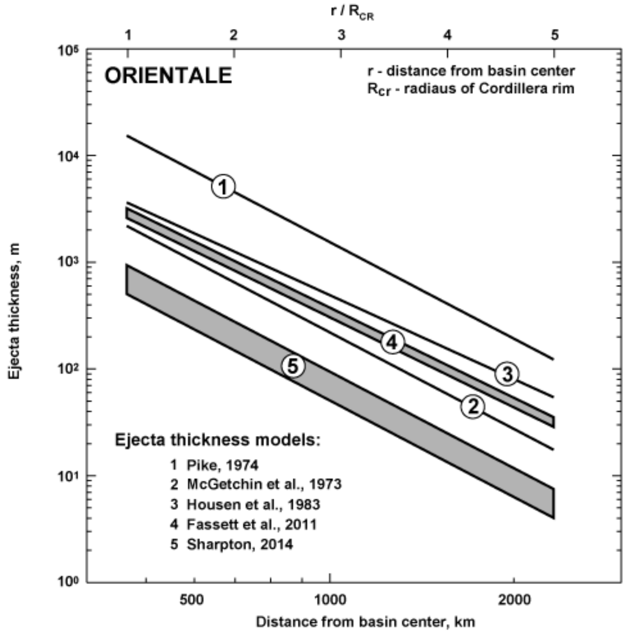

Fig. 1. Radial ejecta thickness of the Orientale basin according to different models.

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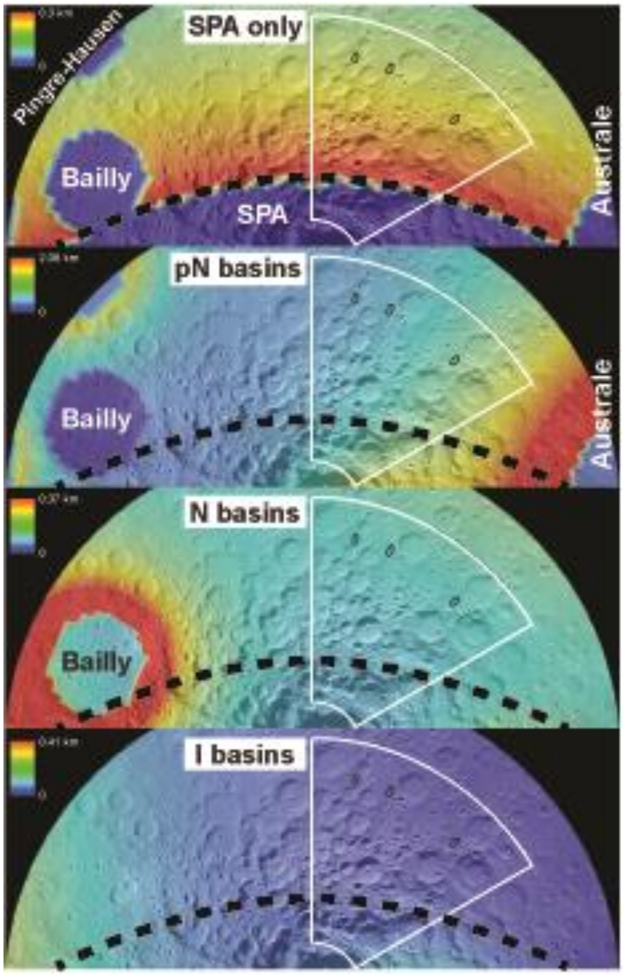

Fig. 2. Model estimates of the thickness of lunar basin ejecta in the LG landing zone (white outline).