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INTRODUCTION

The distribution of anorthosite (rock composed of at least 90% plagioclase feldspar) on the lunar surface can provide important information regarding the geologic history of the Moon. Evidence suggests that the early Moon was covered by a magma ocean which differentiated as it crystallized, forming a plagioclase flotation crust and a cumulate pile of denser mafic minerals. Subsequent bombardment of the lunar surface has disrupted the original flotation crust, and most of the remnants have been obscured by more mafic deposits, but the distribution of the outcrops of pure anorthosite that have been identified holds important implications for the evolution of the lunar crust.

NEARSIDE

Studies utilizing ground-based near infrared reflection spectra have demonstrated that nearside anorthosite outcrops occur primarily in a narrow band running from the inner Rook Mountains in the west to the crater Petavius in the east [e.g., 1-7]. Most of these deposits are associated with basin rings. This association is significant only for the inner rings of basins such as Humorum, Grimaldi, and Orientale. These rings were derived from beneath more mafic-rich layers in the pre-impact target sites. In contrast, the anorthosites associated with the outer rings of Nectaris and other basins are found in the central peaks and walls of large impact craters. It appears that these anorthosites were derived from layers many kilometers beneath the crater target sites and that the surfaces of these outer rings are not composed of anorthosite.

Recently, data from the Galileo and Clementine spacecraft missions have been utilized to investigate the distribution of anorthosite on both the nearside and farside of the Moon. Lucey *et al.* [8] have developed a method of determining iron abundance using data from the Clementine spacecraft, and a global map of Fe abundance has been produced at 35-km resolution. The same method has been adapted for the Galileo SSI data and used to produce regional FeO maps with a resolution of a few km per pixel [9]. These maps are in good agreement with the evidence derived from ground-based spectroscopy for the distribution of anorthosite deposits in such areas as Humorum and Nectaris. In addition, data from these spacecraft has identified a few more likely anorthosite outcrops, for example at Aristarchus, Cyrillus, and Proclus craters [9-11].

FARSIDE

These spacecraft data have revealed a far different pattern of anorthosite occurrences on the lunar farside. Lucey *et al.* [8] demonstrated that large expanses of the lunar farside exhibit very low Fe abundances. The values in some areas are so low that pure anorthosite is clearly exposed. The areas with very low Fe values also exhibit very low TiO_2 abundances [12].

Spudis *et al.* [13] determined the abundance of FeO and TiO_2 for the ejecta deposits associated with selected impact basins on the central farside. Particularly low FeO (~2.7%) and TiO_2 (0.15-0.22%) values were exhibited by the ejecta deposits of Moscoviense and Mendeleev basins. Major amounts of anorthosite are clearly present in these ejecta deposits.

An extensive zone with low (<2.5%) FeO values occurs on the northern portions of the lunar farside (100°E to 100°W and 40°N to 70°N). Low TiO_2 values (<0.3%) also occur within this zone. Within this low FeO zone, there occur large areas which exhibit uniformly very low FeO values (0.1-2.0%). One of the largest of these areas is centered near 55°N, 120°W. Much of this area exhibits extremely low TiO_2 abundances (0.01-0.1%). The very low FeO and TiO_2 values clearly indicate that the surface of this area is composed of pure anorthosite.

Two pre-Nectarian basins are located in this area: Coulomb-Sarton (dia=530km) and Birkhoff (dia=330km). After the formation of these basins, the area was little affected by other basin-forming impact events. This area may represent a relatively undisrupted portion of the ancient lunar crust.

DISCUSSION

It appears that many of these findings can be explained in part by the influence of the ancient, giant South Pole-Aitken basin. This basin must have deposited great quantities of ejecta over much of the farside. Lucey *et al.* [12] estimate that the ejecta near the rim of the basin contains about 3-4 wt.% FeO and about 0.3 wt.% TiO_2. These values are typical of the lunar highlands and clearly higher than those for anorthosite. Near the basin rim, only very large impacts, such as that which produced the Orientale basin, could have penetrated the thick layer of South Pole-Aitken ejecta there to reveal the pure anorthosite below it. In more distal regions, smaller basins could have ejected material composed of a mixture of anorthosite and the South Pole-Aitken ejecta overlying it.

The region in the northern farside which exhibits such extremely low FeO and TiO_2 values is far enough from South Pole-Aitken that much less South Pole-Aitken ejecta would have been supplied to the area. Impact structures such as the Birkhoff and Coulomb-Sarton basins which formed there could easily have penetrated any South Pole-Aitken ejecta present to expose the pure anorthosite there.

Efforts are currently underway to produce a global iron map at approximately 1km resolution using Clementine data. This data product should help to refine our understanding of the nature and extent of lunar anorthosite deposits. While many details remain to be resolved, the big picture of anorthosite distribution on the lunar surface is beginning to come into clearer focus.

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