**GEOCHEMICAL UNITS ON THE MOON: THE ROLE OF SOUTH POLE-AITKEN BASIN. .** C. A. Peterson[1], B. R. Hawke[1], D.T. Blewett[1,2], D. B. J. Bussey[1] P. G. Lucey[1], G. J. Taylor[1], P. D. Spudis[3], [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI 96822, [2]NovaSol, 1100 Alakea Street, 23rd floor, Honolulu, HI 96813, [3]Lunar and Planetary Institute, Houston, TX 77058.

**Introduction:** Earth's Moon has been subjected to bombardment by bodies of various sizes since its formation more than 4.5 billion years ago, especially during the first half billion years of its existence. Yet, to a surprising degree, many of the large-scale geochemical provinces found on the Moon today are strongly linked to a single impact, the one that created South Pole-Aitken (SPA) basin. This event influenced the exposures of rock we see today in the SPA interior and ejecta blanket, an area comprising a substantial portion of the Moon's surface.

South Pole-Aitken basin is the largest and oldest unambiguously identified impact structure on the Moon. It has a topographic rim about 2500 km in diameter, an inner shelf 400 – 600 km in width, and an irregular depressed floor at an elevation about 12 km below the rim crest [1]. Topographically high regions surround the SPA basin and are especially pronounced to the north and east; models also show very high levels of crustal thickness in those areas and relatively thin crust beneath the basin [2].

The existence of the SPA basin was inferred from Earth-based photographs and early spacecraft images [1]. However, since it is located almost entirely on the Moon's farside, SPA cannot be studied extensively using Earth-based telescopes. When the Galileo spacecraft passed the Moon in 1990, it returned images that revealed a distinctly lower albedo in the SPA interior compared to other highland areas [3]. Multispectral images returned by the Galileo and Clementine spacecraft provided a means to investigate more thoroughly the composition of units associated with SPA. Belton *et al.* [3] noted an enhancement in mafic materials in the SPA interior. Lucey *et al.* [4] derived methods that use Clementine UVVIS data to quantify the iron and titanium content of lunar surface materials and, in addition to confirming the enhanced FeO content in the basin interior, noted that regions in the far northern farside are extremely low in FeO. This indicates extensive exposures of anorthosite.

More recently, the Lunar Prospector spacecraft returned GRS data that are being used to produce elemental abundance maps [5]. Preliminary thorium maps have been produced [6], and iron maps are also being produced using techniques totally independent from those used with the Clementine data.

Our purpose here is to examine these data sets in order to investigate the nature of the geochemical provinces in this region and to determine the role of the SPA impact event in their formation.

**Method:** Clementine UVVIS data cover most of the Moon between 70°N and 70°S [7]. We have used these data to produce FeO and $TiO_2$ maps at a variety of resolutions. The best spatial resolution approaches 100m per pixel. Five color spectra can be extracted from the UVVIS data. Clementine also returned near-IR data [7], and work is continuing to produce spectra from these data.

Elemental abundance maps derived from data returned by the Lunar Prospector mission are currently being produced. A preliminary thorium map is available for analysis.

The highest values on both topography and crustal thickness maps are found in the same part of the SPA region [2]. These can be compared with models of ejecta emplacement in order to estimate the extent of the influence of the SPA impact event in regions far removed from the basin.

**Results and Discussion:**

*SPA Interior*: Apollo orbital geochemistry data were obtained for the northern portion of the SPA basin, and these indicated an anomalous composition [8]. Enhanced FeO and Th values were noted. The mafic nature of the basin floor was confirmed by Galileo multispectral data [3]. Additional evidence concerning the anomalous compositions of SPA floor units was provided by Clementine and Lunar Prospector.

It has been suggested [9,10] that the mafic enhancement of the basin floor results from the exposure of lower crustal or perhaps even mantle material. A basin the size of SPA should have been able to excavate such deep material [1]. Recent work demonstrates that neither cryptomaria nor pyroclastic deposits can account for the mafic character of the SPA interior deposits [11,12].

There have been recent suggestions that the Th (and possibly the FeO and $TiO_2$) enhancements in SPA are due at least in part to major thicknesses of Imbrium ejecta that were deposited in the vicinity of the Imbrium antipode [13]. While some amount of FeO and Th-rich Imbrium ejecta may be present at the basin antipode, it seems unlikely that the mafic and Th anomalies on the interior of SPA basin can be fully attributed to Imbrium ejecta. The evidence is as follows:

Enhanced FeO and $TiO_2$ values are seen in various portions of the SPA interior and not just in the vicinity of the antipode. In the vicinity of the antipode, several large post-Imbrium craters expose Th-rich material excavated from a depth of several km. This is far below the level of any reasonable thickness of Imbrium ejecta. Other large impact craters excavate Th-rich material from the subsurface in portions of the SPA floor far from the Imbrium antipode. We must conclude that the Th enhancement on the interior of SPA was not produced by the emplacement of Imbrium ejecta. However, Imbrium ejecta may contribute to the enhancement in the antipode area. Finally, the results of calculations have recently been presented by Wiecaorek and Zuber [14] which suggest that Imbrium ejecta would not be concentrated at the mapped antipode because of lunar rotation during ejecta transport in ballistic trajectories.

*SPA Exterior – Farside & West Limb*: There is an anorthosite-rich zone on the northern farside identified by Lucey *et al.* [15]. This area exhibits extremely low FeO values. More recent work using higher resolution Clementine imaging data generally supports this interpretation [16]. Support is also provided by $TiO_2$ data as well as Lunar Prospector Th data. Lucey *et al.* [15] suggested that this anorthosite zone might be the surface of the plagiocalse-rich flotation crust formed by the crystallization of the magma ocean.

SPA ejecta on the farside and western limb: The terrain that lies between the mafic anomaly on the interior of SPA and the "anorthosite-rich" zone exhibits intermediate FeO abundances. The intermediate FeO terrain should have been covered with large but varying thicknesses of SPA ejecta. This intermediate terrain can be divided into inner and outer zones. The inner zone is more mafic (FeO-rich) and is located between the transient crater cavity ring and the main (outer) ring. It is covered by thick SPA ejecta. The outer zone is much less mafic and is located between inner zone and the "anorthosite-rich" zone. Small areas of very low FeO material, interpreted as pure anorthosite, occur in the outer zone. Many of these are correlated with inner rings of post-SPA basins that appear to expose anorthosite from beneath more mafic SPA ejecta deposits. Examples of such basins include Hertzsprung, Korolev, Orientale, and Grimaldi [16].

*SPA Exterior – Nearside*: SPA is centered on the southern farside; its outer ring extends into the southernmost portion of the lunar nearside. Because of its location, SPA must have emplaced vast amounts of ejecta in the southern highlands and on the lunar nearside in general. We suggest that relatively mafic SPA ejecta was emplaced on top of pure anorthosite in the southern highlands. Exposures of anorthosite are rare in the southern highlands but they do exist. Thompkins and Pieters [17] identified two exposures of anorthosite in the central peaks of craters in the far southern nearside. No basins exist that might have exposed anorthosite in the far south, but farther north the Mutus-Vlaq and Humorum basins have exposed anorthosite from beneath the more mafic surface material.

**Summary**: Although the SPA basin region has been heavily modified by billions of years of impacts, some of the effects of the SPA basin-forming impact are still clear. The impact excavated deeply into, or perhaps entirely through, the existing crust to expose mafic lower crustal or mantle material. Much of the Moon's original flotation crust, composed of anorthosite, was likely intact at that time, and enormous quantities of SPA ejecta covered and protected much of it, especially near the basin. Subsequent impacts have, in some cases, been able to expose anorthosite from beneath the more mafic SPA ejecta.

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