THE SIZE AND LOCATION OF THE TRANSIENT CRATER OF THE SOUTH POLE-AITKEN BASIN

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Introduction: The large South Pole-Aitken basin (SPA) is home to a host of rock types [1]. We have examined these rock types using the Clementine UVVIS data in and around the SPA basin in order to identify regions that contain a surficial component of upper crust (eg. abundant anorthosite). Since the SPA impact event is expected to have excavated deep into the lower crust or mantle, the locations of any remnant anorthositic regions within the basin will aid in determining the location and size of the transient crater.

Size of the impact basin: The large SPA basin was originally mapped by Stuart-Alexander [2] as being centered at -50°, 180° with a diameter of 2,000 km. Wilhelms et al. [3, 4] defined a center at -56°, 180° and a diameter of 2,500km (Figure 1). Subsequently, Pieters et al. [1] proposed a new center 15° east of the center proposed by Wilhelms, at -56°, 165°E. This proposed location was based on topography, the distribution of feldspathic material, and the distribution of impact melt breccia.

Size of the Transient Crater: Warren et al. [5] apply a crater scaling model by Croft [6] to the SPA basin and determine that the transient crater would be 1,170km in diameter, assuming a crater diameter of 2,500km. This also assumes that the scaling relationship determined for Imbrium by Croft (0.468) applies to a basin that is 1.7 times larger in diameter. For craters larger than 500km in diameter, the scaling relationship varies from 0.464 for Crisium (D_r=1,098km) to 0.534 for Freundlich-Sharonov (D_r=601km). There exists clearly some variability in the relationship, although Croft determines that for multiring basins like Imbrium the scaling ratio should be approximately 0.500. Using these relationships would mean that the SPA basin should have an estimated transient crater diameter of 1,250km.

Feldspathic materials within the basin: Several studies have identified locations within the SPA basin where anorthosite has been found. Morrison [7] identified anorthositic material in the outer ring and the peak ring of Apollo and Pieters et al. [1] identified additional feldspathic materials in the ring of Ingenii and near the crater Leibnitz. We expand these analyses to include the full basin and surroundings and use any distinctly anorthositic composition within the basin as a marker to indicate the limits of the SPA transient cavity.

In examining the SPA basin, Clementine UVVIS spectra are used in conjunction with the FeO algorithm derived by Lucey et al. [8]. The FeO estimates are used to provide an overview of the basin and its surroundings. We can then evaluate the locations of possible low FeO content (anorthositic) within the basin. Figure 2 is a map of FeO estimates in and around the SPA. Several locations of possibly low FeO occur within the basin. 5-color spectra of UVVIS data are then used to evaluate these locations in order to determine if they do in fact represent anorthositic material of the upper crust.

In evaluating the areas of potential low FeO, several were shown not to contain anorthosite based on geologic context and 5-band spectra. On the other hand, several areas within the SPA basin are clearly identified as anorthositic based on this procedure. Examples include the crater O'Day [e.g. 9] and the northern rim of the basin Poincare. These exposures of anorthositic material are similar to those in Leibnitz and Apollo (Figure 2). The only exposure at Poincare is found on the northwestern rim of the basin. The exposures at Apollo, Poincare, Leibnitz possibly represents upper crustal material exposed at the surface that has not been involved in the transient crater excavation. Example spectra taken from Apollo, Poincare, Leibnitz, and Ingenii show that the exposures represent upper crustal (anorthositic) material (Figure 3).

Extent of feldspathic materials and the transient crater: Assuming that the exposures of anorthositic materials at Apollo, Poincare, and Leibnitz represent upper crustal material, we derive the extent of the transient crater based on the innermost occurrence of anorthositic materials. Using the northern rim of Poincare, the southern rim of Leibnitz, and the peak ring of Apollo as the innermost locations of upper crustal material, an estimation of the transient crater can be determined (Figure 4). The estimated transient crater has a diameter of 1,260 km and is approximately centered at -56°, 170°E. This diameter yields a scaling ratio of 0.504, approximating the 0.500 value for large basins described by Croft [6]. However, this description of the SPA transient crater is based on only a few exposures of anorthositic materials, and the derived position is currently tentative.

Conclusions: The boundary of the transient crater of the SPA is preserved in a few outcroppings of anorthositic materials along the rims of Apollo. Poincare, and Leibnitz. These locations define a ring approximately 1,260km in diameter centered about -56°, 170°E. The size of the transient crater agrees with the scaling relationship determined by Croft [6] and its center roughly agrees with the center proposed by Pieters et al. [1].

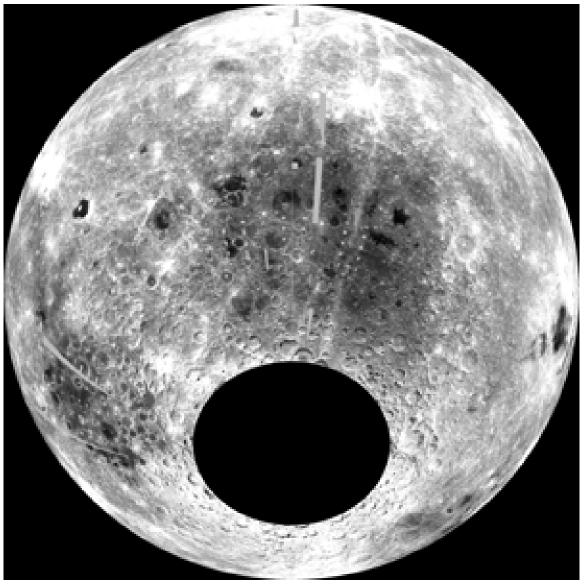

Figure 1. Clementine 750nm albedo image of the South Pole-Aitken Basin. The projection is orthographic and is centered on -56°, 180°, Wilhelms' [1] proposed center.

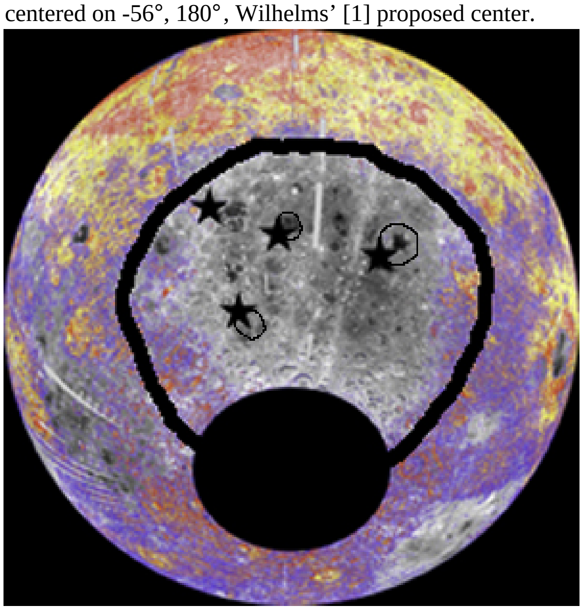

Figure 2. Location map showing the SPA basin as defined by Wilhelms [4]. Examples of upper crust material (anorthositic) associated with later impacts within the SPA basin are shown with stars (see figure r for spectra). The outlines of the basins Apollo and Poincare and crater Leibnitz are defined by fine lines. The colors represent %FeO estimates of Lucey et al [8] where red is <3%, yellow is 3-4%, maroon is 4-5%, and blue is 5-6%.

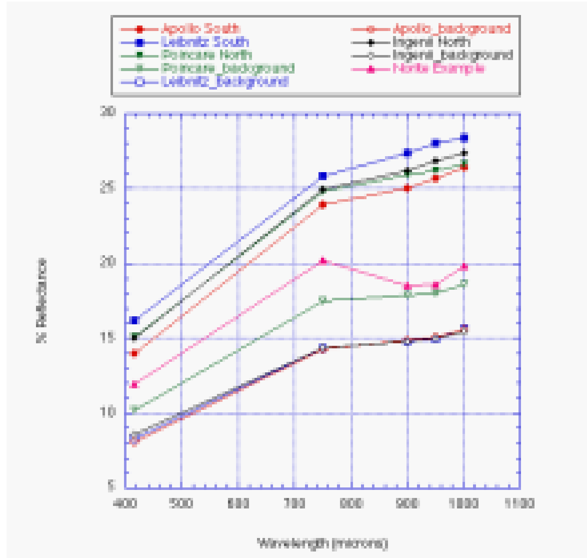

Figure 3. Clementine UVVIS spectra taken at locations within the SPA identified has having upper crustal material, background values from near each location, and an example of typical norite for comparison.

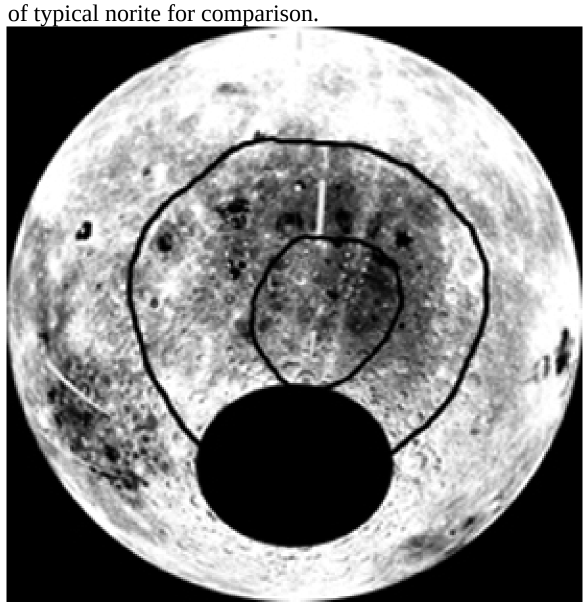

Figure 4. The rim of the basin as defined by Wilhelms [4] is represented in the outer line. The inner line represents the hypothetical transient crater as defined by the presence of upper crustal material within the basin. This would place the center at approximately -56°, 170°.

References: [1] Pieters, C. M. et al. (2001) *JGR, 106*, 28,001-28,022. [2] Stuart-Alexander, D. E. (1978) *USGS Misc. Inv. Series I-1047*. [3] Wilhelms, D. E. et al. (1979) *USGS Misc. Inv. Series I-1162* [4] Wilhelms, D.E. (1987) *USGS Professional Paper 1348*. [5] Warren, P.H., et al. (1996) *GSA Special Paper 307*, 105-124. [6] Croft, S.K., (1985) *PLPSC XV*, C828-C842. [7] Morrison, D. A. (1998) *LPS XXIX*, #1657. [8] Lucey, P. G. et al. (2000) *JGR, 105*(E8), 20,297-20,305. [9] Tompkins, S. and Pieters, C.M., (1999) *MAPS, v. 34 no. 1*, 25-41.