THE LUNAR CRISIUM BASIN: GEOLOGY, RINGS, AND DEPOSITS. Paul D. Spudis[1], B. Ray Hawke[2], and Paul G. Lucey[2] 1. U.S. Geological Survey, Flagstaff AZ 86001 2. Planetary Geosciences-HIG, Univ. Hawaii, Honolulu HI 96822

The Crisium basin is on the eastern edge of the lunar near side north of Mare Fecunditatis and southeast of Mare Serenitatis. The basin impact appears to have occurred within typical highlands, although evidence exists that mare volcanism was active in this region prior to and immediately after the impact [1]. The basin interior is mare-flooded, obscuring relations for the basin floor and causing controversy regarding the true topographic rim of the basin [2,3].

Geology of Crisium Deposits The highlands bounding the basin consist of well-preserved massifs. The Crisium rim consists of platform topography in which mesa-like terra islands of polygonal outline contain undulatory to smooth interplatform deposits of light plains or hummocky deposits; the latter may also overlie the platforms. These platform massifs are much more prominent and abundant than those at the Nectaris [4] and Imbrium [5] basins and appear to make up most of the highlands that surround Mare Crisium for about a basin radius (250 km). Schultz [6] suggested that these platform massifs were produced by endogenic modification of basin topography.

The highlands on the southern border of the Crisium basin display several morphologies that render interpretation of basin geology difficult. Large exposures of hilly and furrowed material [7] occur in this region and appear morphologically similar to the Descartes materials exposed west of the Nectaris basin [4]. The rim of Cleomedes, a post-Crisium crater on the northern rim of the basin, is overlain by a deposit of this hilly material. Therefore, at least in this region, the hilly material cannot be a facies of Crisium basin ejecta because it overlies a crater that post-dates the basin.

Distal Crisium deposits are difficult to recognize in most regions [2]. Sparse patches of lineated terrain occur north of the basin, terminating near the crater Messala and probable basin secondaries are exposed near the crater Zeno. The elongate crater Rheita P, that is superposed on the Nectaris basin Jannsen Formation, may be a Crisium basin secondary crater; this relation implies that Crisium post-dates the Nectaris basin [8].

Rings and structural geology A subtle ring structure 1080 km diameter has been interpreted as the main topographic rim of the basin [2,3]. Most other investigators interpret the main basin rim to be the scarp-like ring (740 km in diameter) just outside the massif ring bordering the mare (540 km diameter) [9,10]. Highland elevations of the 740 km ring equal or exceed those of the 540 km ring bordering the mare; thus, this ring probably represents the true topographic rim of the Crisium basin. Two large, exterior rings of 1080 and 1600 km diameter possess scarp-like morphology and resemble the outer rings of the Nectaris and Imbrium basins [4,5]. One additional inner ring (360 km diameter) is expressed by the wrinkle ridge system of Mare Crisium.

One of the most distinctive structural features of the Crisium basin is the presence of concentric troughs that occur between the platform massifs that make up the basin rings. These troughs are evident on both low-sun telescopic photographs and topographic data derived from orbiting spacecraft. The troughs appear to be structurally controlled and display polygonal outlines.

Composition of Crisium basin deposits. Orbital chemical and Earth-based spectral data. The regional composition of the southern Crisium terra is that of typical near side highlands. Mixing model calculations [11] performed on four regional units [12] show all to be more or less constant in petrologic composition. Three of the highlands units are nearly identical, being composed of anorthositic gabbro and low-K Fra Mauro basalt in the approximate proportions of 3:1. A fourth unit, correlated with interplatform light plains, displays a mare basalt component (almost 19 percent). Two near-infrared spectra exist for Crisium deposits [13]: that of the crater Proclus shows a composition of anorthositic norite while that for the small crater Eimmart A indicates a feldspathic rock with both orthopyroxene and olivine [13]. The compositions of Crisium basin ejecta are comparable with those observed in Nectaris [4], in which anorthositic components make up the majority of basin deposits and LKFM is less abundant. Both basins probably excavated comparable stratigraphic levels (not necessarily comparable depths) of the lunar crust.

Luna 20 Samples. The Soviet unmanned spacecraft Luna 20 landed on the southern rim deposits of the Crisium basin near the crater Apollonius. Anorthositic particles are the most abundant component of the soil, making up about 75 percent of the sample, while Low-K Fra Mauro basalt contributes about 18 percent to the total Luna 20 soil [14]. Lithic fragments with LKFM composition are aphanitic impact melts. These rocks may represent ejected Crisium basin impact melt that is included within anorthositic clastic ejecta at the Luna 20 landing site. Such a relation is similar to that of VHA melt rocks found in the Apollo 16 samples that were probably derived from the Nectaris basin impact [4].

About 9 percent of the Luna 20 soils consist of mare basalt mineral fragments and agglutinates [14]; mixing model calculations of orbital data range from 2 to 18 percent mare basalt, in reasonable agreement. These mare basalt fragments may be derived from the post-basin Mare Crisium and Mare Fecunditatis flows, delivered to the site by impact craters but the evidence for ancient, basin-related mare deposits, both as ejecta and post-basin interplatform flows [1], suggests that at least some of these fragments may be part of the Crisium ejecta.

Discussion. Remote-sensing and Luna 20 data suggest that excavation at Crisium basin was limited to upper and middle crustal levels (40-45 km), as at the Nectaris basin [4]. The lowermost boundary for the transient cavity diameter is probably the inner mare ridge ring, about 380 km in diameter; if smaller than this, inner basin topography would probably be more prominent within Mare Crisium and terra islands would be evident within the mare fill of the basin. The maximum size of the transient cavity is probably less than or equal to about 540 km in diameter, corresponding with the prominent massif ring that contains the mare fill of the basin. If the impact cavity were much larger than this, lower crustal and mantle material would have been excavated. We suggest a transient cavity diameter of about 450 km for the Crisium basin [4,5].

Platform massifs result from the penetration of the lunar lithosphere by the basin-forming impact, followed by sub-lithospheric flow and foundering of crustal blocks. The impact induced radial and concentric fractures in the rigid lithosphere; such fracturing has been predicted theoretically [15] and documented by observations [16]. After the impact, the lunar asthenosphere flowed inward to compensate for the excavated mass. Because the viscosity of the asthenosphere was variable laterally on small scales, the regional inward flow produced platforms by selective removal of underlying support; the failure occurred along the zones of weakness induced earlier. Such a mechanism for the production of platform massifs would explain their absence around young lunar basins, such as Orientale; these basins formed after the lithosphere had grown so thick that the basin transient cavity occurred entirely within the rigid layer.

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