INTERPRETING THE DEPTH OF ORIGIN OF THE SCHRÖDINGER PEAK RING AND IMPLICATIONS FOR OTHER IMPACT BASINS.

David A. Kring, Georgiana Y. Kramer, and Ross W. K. Potter, Center for Lunar Science and Exploration, USRA-Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058 USA (kring@lpi.usra.edu).

Introduction: Uplifted impact basin peak rings can be used to probe planetary interiors. On the Moon, the ~320 km diameter Schrödinger basin is the best preserved basin of its size and has an extraordinary peak ring with which to evaluate the differentiation of the lunar magma ocean. The peak ring has a diameter of ~150 km and rises 1-2.5 km above the basin floor, providing an immense cross-section of the deep crust and possibly upper mantle. Dramatic exposures of anorthositic, noritic, and olivine-bearing (troctolite?) lithologies have been detected with Kaguya, Chandrayaan-1, and Lunar Reconnaissance Orbiter data [1-3]. Key to interpreting them, however, has been estimates of the lithologies' depths of origin.

Competing models: For lunar central peak craters, Cintala and Grieve [4] pointed out that uplifted melt cannot form the bedrock peaks, implying the minimum depth of origin for central peaks is the maximum depth of melting. They derived an analytical equation relating structural uplift with final crater diameter [5]. If one applies that equation to Schrödinger, one obtains an estimate for structural uplift of 94 km, which should have exposed material from the lunar mantle.

Schrödinger, however, is a peak ring basin, not a central peak crater. Cintala and Grieve [5] suggested an alternative uplift model for structures of this size. Rather than having the topographically exposed structure rising from the crater center, they suggested it rises from a ring of rock bounding the region of impact melted material. In this model, peak ring lithologies come from shallower depths than the maximum depth of melting. This model is appealing, because it is consistent with the observation of crustal anorthosite, rather than mantle lithologies, in some lunar peak rings [5]. This model has also been recently amplified by Head [6].

We prefer to interpret the Schrödinger peak ring with an alternative model wherein central peaks and peak rings are produced by a similar central uplift process, but in which the central uplift collapses to form the peak ring. This is a model highlighted by hydrocode modeling (e.g., [7,8]) and consistent with observations of the Chicxulub impact structure.

While this model treats the process of uplift in peak ring craters and central peak craters in the same way, one cannot use the equation of Cintala and Grieve [5] to calculate the depth of origin for material in the peak ring. The collapse of the central uplift in the formation of peak ring basins alters the amount of final uplift and distribution of lithologies. During the collapse, for example, the material in the central uplift flows outward, producing nappe-like structures that collide with the inward collapsing walls of the transient crater. The material exposed in that collapsed central structure are not the deepest uplifted units, but rather lithologies that are derived from only a fraction of the transient crater depth. That implies a crustal origin (e.g., 20-30 km depth) for the lithologies within the Schrödinger peak ring, although faulting through the collapsed peak ring [9] could juxtapose and expose units from a range of depths.

Conclusions: This model provides continuity in the processes that produce central peaks (e.g., in Copernicus) and peak rings like that in the Schrödinger basin. Because it generates surface exposures that are derived from depths significantly less than that of the transient crater, it is also consistent with the observations of anorthosite in many lunar peak rings. For the specific case of the Schrödinger basin, the model implies the lithologies in the peak ring will be dominated by crustal lithologies.

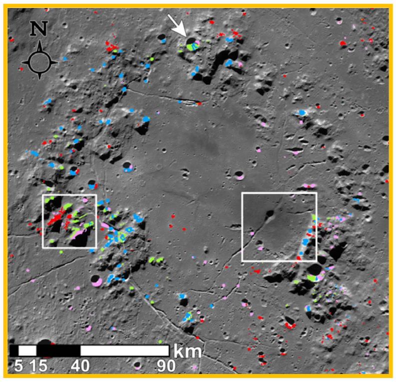

Fig. 1. Peak ring within the Schrödinger basin; anorthositic (blue), noritic (red), and olivine-bearing (green) areas where lithologies are identified; and 3 possible sample sites.

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