ORIENTALE BASIN: FORMATION PROCESSES AND STRUCTURE INFERRED FROM HYDROCODE MODELING R. W. K. Potter[1,2], D. A. Kring[1,2], G. S. Collins[3], W. S. Kiefer[1,2], and P. J. McGovern[1,2], [1]Center for Lunar Science and Exploration, Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston, TX, 77058, USA, [2]NASA Lunar Science Institute, potter@lpi.usra.edu; [3]Dept. Earth Science and Engineering, Imperial College London, London, SW7 2AZ, UK

Introduction: As the youngest and best-preserved lunar multi-ring basin, Orientale has been used as the archetype for investigating basin formation processes and structure (e.g., [1,2]). Numerous aspects of Orientale, however, remain uncertain, e.g., transient crater dimensions and melt volume. Here, we summarize the results of [3], where we numerically modeled the Orientale basin-forming event to resolve some of the uncertainties associated with its formation and structure.

Methods: Orientale-sized impacts were numerically modeled using the iSALE hydrocode (e.g., [4]). The target was divided into crust (60 km thick) and mantle layers, each with properties appropriate for their lunar counterparts. Two thermal profiles [5], estimating lunar thermal conditions at the time of Orientale's formation ~3.8 Ga, were used. Impactor diameter varied between 40 and 120 km; impact velocity varied between 10 and 20 km/s. All impacts were vertical.

Results: The location and thickness of Orientale's crustal annulus, inferred from gravity data [6], was used to constrain the models to find best-fit impact scenarios for each thermal profile.

Thermal Profile 1 (hot mantle). The best-fit scenario had a 50 km diameter impactor hitting at 15 km/s. A transient crater ~320 km in diameter was produced, similar in size to Orientale's Inner Ring (IR). Material was excavated from a maximum depth of 42 km (within the lower crust). The volume of mantle melt produced was $1.1x10^6$ km^3. Analysis of material deformation suggests thrust and normal fault-like features at locations equivalent to Orientale's IR and Outer Rook Ring (ORR), respectively (Figure 1).

Thermal Profile 2 (cool mantle). The best-fit scenario had an 80 km diameter impactor hitting at 15 km/s. A transient crater 466 km in diameter was formed, slightly smaller than Orientale's Inner Rook Ring (IRR: 480 km). The maximum excavation depth was 55 km (within the lower crust). The volume of mantle melt produced was $2.4x10^6$ km^3. Analysis of structural deformation showed thrust and normal fault-like features at locations equivalent to Orientale's IRR and Cordillera Ring (CR), respectively.

Melt volumes agree with previous work (~10^6 km^3; e.g., [7]), as does the absence of excavated mantle [8] and the inferred faulting within the basin [9]. The ORR has previously been suggested as marking the extent of the transient crater [10]; our models suggest a smaller diameter.

Discussion: Though thermal conditions similar to TP2 cannot be ruled out, the best-fit impact scenario using TP1 appears more appropriate for the Orientale-forming event as: (1) normal fault-like features and material distribution around the ORR agree with previous work [9]; (2) only upper crustal material is found beyond the CR, agreeing with the highly feldspathic composition [11]; and (3) the elevation and radial location of the topographic high in the TP1 scenario matches observations [12].

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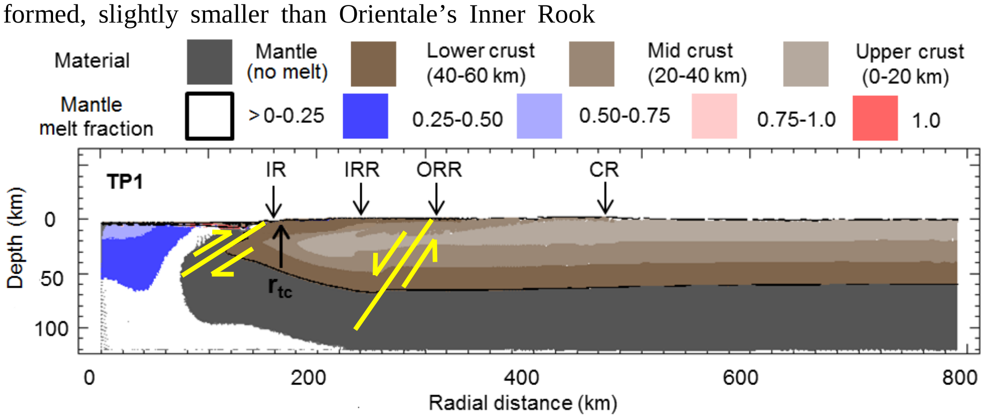

Figure 1: Material and mantle melt distribution, as well as inferred faulting, for the best-fit Orientale model using Thermal profile 1. Also shown: transient crater radius (r_{tc}) and Orientale ring structures.