DISTINCT EVIDENCES OF CENTRAL PEAK MODIFICATION IMPLY CAUTION FOR THE DERIVED SUBSURFACE MINERALOGY: EMERGING RESULTS FROM GLOBAL SURVEY Deepak Dhingra¹ Sai A. D. Bhoga¹ and Vidhya Rengarajan², ¹Department of Earth Sciences, Indian Institute of Technology Kanpur, Uttar Pradesh 208016, India (deepdpes@gmail.com), ²University of Western Ontario, Canada.

Introduction: We report here distinct evidences of central peak modification and emphasize their potential role in influencing the mineralogical character of the central uplifts. Central peaks in impact craters are key locations to decipher the sub-surface composition up to several kilometers. They have been extensively used for over four decades to reveal the global lunar sub-surface composition [viz. 1-4]. This information has then been used as an input to understand and constrain large-scale evolutionary processes, most importantly, the lunar magma ocean [5].

It is however, increasingly becoming clear with high resolution and multiple illumination datasets that central peak structures (even at some of the youngest complex craters) are not as pristine as previously believed [viz. 6-8]. As a result, their mineralogical character cannot be directly used as an input in inferring the sub-surface mineralogy.

Global survey of central peak modification: We report here results from an on-going global study of central peaks with the following objectives:

a) To constrain the nature and extent of central peak modification at various Copernican and Eratosthenian craters.

b) To develop an analysis approach based on the modification of the peaks such that their scientific reliability can be maximized for mineralogical studies.

Nature of modification: We observe multiple modes of modification of the central peaks.

i) Ejecta deposition from later formed craters: Several central peaks have been covered (to different extent) by material ejected during the formation of later formed, younger craters. It is evident by clearly defined ray paths and could potentially also include impact melt [9], in addition to the pulverized ejecta. e.g. crater Robertson (61 km diameter; 21.84°, 254.63°) and crater Carpenter (60 km diameter; 69.51°, 308.76°).

ii) Draping of central peaks with impact melt during crater formation (in-situ material): Impact melt deposits have now been mapped on several prominent central peaks including Tycho and Jackson [10], clearly modifying the pristine sub-surface composition. Since impact melt is derived from multiple depths, its presence on the central peaks would influence any inference of a systematic compositional record.

Extent of Modification and Implications: We are using both spectral and morphological criteria to identify and quantify central peak modification by various processes. Preliminary estimates suggest substantial part of the peak (>50%) getting affected, although it would vary among craters. It should also be noted that many such evidences get progressively muted due to space weathering.

Figure 1 Central peak modification at crater Robertson. Ray material ejected during the formation of younger crater Ohm, is directly crossing over the peaks of Robertson crater, modifying its surface characteristics. The dashed arrows point to the direction of ejecta movement.
Determination of the lunar crustal composition variations with depth clearly merit careful re-look in view of distinct cases of central peak modification by multiple geological processes. Our global study is providing strong motivation for this revision and would enable better constraints on the crustal compositional trends which would inform the understanding of major evolutionary processes including the lunar magma ocean.

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References:

Figure 2 Central peak modification at crater Carpenter. (a) The central peak shows a narrow zone (marked by white dashed lines) of crater clusters, likely secondary craters from a nearby impact. (b) A portion of the peak displays smeared surface (marked by magenta arrows), potential scouring by ejecta from a subsequent impact event. Image source: LROC NAC.