RADIAL MINERALOGICAL TRENDS IN FRESH IMPACT CRATERS ON MOON – FORMATION PROCESSES & SIGNIFICANCE

D. Dhingra, Planetary Sciences & Exploration Programme, Physical Research Laboratory, Navrangpura, Ahmedabad – 380009, India (deepakd@prl.res.in)

Introduction: Impact cratering systematically excavates material from the sub-surface and deposits it in a sequential manner as ejecta around the crater. The nature of compositional variation of the ejecta lends important insights into the planetary sub-surface in terms of pre-impact stratigraphy and its geological character.

The present study is aimed at characterizing the mineralogy of fresh lunar craters on the crater floors that may reflect original floor composition [1]. Floors of craters of various sizes were sampled to ascertain any change in mineralogy with depth which is expected as a result of crystallization of lunar magma ocean.

Dataset: Qualitative estimates of mineral abundances have been made using modified version of algorithm given by [2] and [3]. Clementine UV-VIS datasets available from USGS Astrogeology Map-A-Planet website, have been used for the study at a resolution of 500m/pixel. Individual mineral maps of anorthosite (and/or mature soils), olivine/high-ca pyroxene and low-ca pyroxene have been generated instead of generating a RGB image. Individual maps appear to provide a better idea of finer variations in mineralogy. Each mineral abundance map is colour coded for better visualization.

Results: Many fresh craters on the floors of pre-existing craters exhibit radial trends in mineral maps generated in this study (Fig.1,3,4). Such occurrences are least expected on crater floors owing to their disturbed nature in terms of likely presence of impact melt, possible subsidence of floor material, material movement from crater walls, variable mixing of material at different locations etc. Similar radial trends are also noticed in fresh craters in areas around target craters (Fig. 5-8) which represent a different geological setting.

Discussion Two possible explanations for such radial mineralogical patterns observed on crater floors and away from target craters are:

a) Impact into a crystallized sequence that will excavate & deposit various mineralogies giving a radial trend.
b) Impact into a sequentially deposited ejecta pile that may excavate and redistribute material to give the observed radial pattern.

In the first case, impact into crater floor would excavate material from depth and deposit it giving radial trend. In such a case, as the depth of excavation increases, the ejecta and resulting radial pattern should become increasingly mafic. The same is not observed. For craters ranging in diameters from ~60 to ~150 km, representing excavation depths of ~6 to ~15 km, the radial pattern essentially remains similar.

Alternatively, this could also happen if excavation takes place over a crystallized melt sheet. However, this contradicts the suggestion that differentiation in impact melts even at basin scale is very unlikely on moon [4]. Further, it is very difficult to uniquely identify occurrence of impact melts using existing methods [5,6] and available spatial resolution.

Re-distribution of material through impact in an ejecta pile appears to be a viable cause for the radial structures observed in fresh craters around target craters.

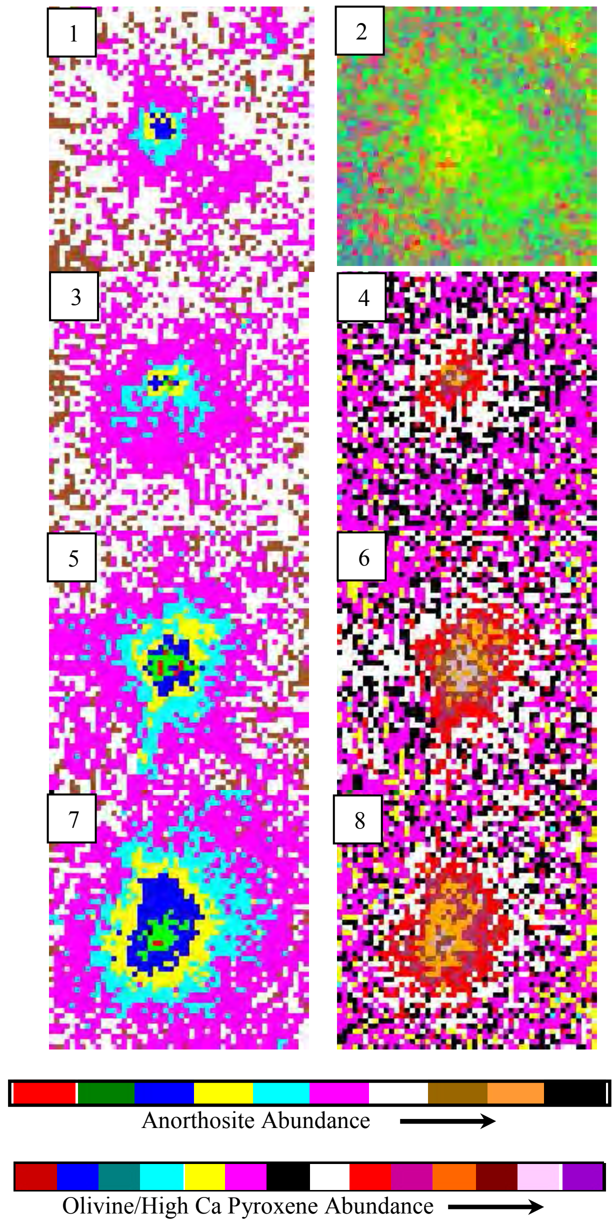

Fig. 1-8 (excluding Fig. 2) show radial trends seen in mineral abundance maps for various fresh craters. Figures 1,3,5,7 are anorthosite maps showing decreasing abundance of anorthosite towards center. Figure 2 is a RGB composite for same crater as in Figure 1 to illustrate the fact that individual mineral maps can show finer variations in mineralogy not visible in RGB images. Figures 4,6,8 are corresponding olivine/high-ca pyroxene abundance maps showing an increase in the concentration towards center. Fresh craters in Fig. 1, 2 and 3, 4 occur on the floors of craters Konstantinov and Keeler respectively. Fresh craters occurring near craters Chaplygin and Anderson are shown in Fig. 5, 6 and 7, 8 respectively.

Conclusions:

1. Radial patterns in mineral maps around fresh craters on Moon have been observed in different geological settings: on the crater floors and in areas around target craters.
2. Such patterns on crater floor can be generated by excavation of a crystallized melt sheet.
3. The observed radial trend in areas away from the target craters could be due to re-distribution of material by excavation of relatively undisturbed ejecta pile.

Our observations and inferences need to be validated with a larger set of radial patterns observed in diverse geological settings.

References:

[1] Dhingra D. (2006) *Int'l Lunar Conference, Beijing,* Abstract. [2] Tompkins S. and Pieters C.M. (1999) *Meteoritics & Planet. Sci, 34*, pp 25-41 [3] Pieters C.M., Head J.W., Gaddis L., Joliff B.and Duke M. (2001) *JGR*, *106, No.E11*, pp28,001-28,022 [4] Warren P.H. (1997) in *Large Meteorite Impacts & Planetary Evolution,LPI Contribution No. 922*, p62 [5] Howard K. A. & Wilshire H.G. (1973) *LPSC Abstracts, Vol. 4*, p 389-390 [6] Hawke B. R. & MacLaskey D. & McCord T.B. (1979) *Conference on The Lunar Highlands Crust, LPI Contribution 394*, p50-52