ORIENTALE MULTI-RINGED BASIN INTERIOR
AND IMPLICATIONS FOR
THE PETROGENESIS OF LUNAR HIGHLAND SAMPLES

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Abstract. The lunar Orientale basin and its associated facies formed as a result of impact into lunar highland crustal rocks. The crater rim is shown to be closely represented by the position of the outer Rook Mountain ring, approximately 620 km in diam. The inner Rook Mountains form a central peak ring within the crater. The 900 km diam Cordillera ring is a fault scarp which formed in the terminal stages of the cratering event as a large portion of the crust collapsed inward toward the recently excavated crater, forming a mega-terrace. This collapse pushed the wall of the Orientale crater inward, distorting it and slightly decreasing its radius.

A domical facies is almost exclusively developed between the Cordillera and outer Rook rings. The domical facies is interpreted to be radially textured ejecta which was disrupted and modified to a jumbled domical texture by seismic shaking associated with the formation of the mega-terrace. The plains and corrugated facies pre-date the mare fill and lie within the Orientale crater. These facies are interpreted to have been deposited contemporaneously with the cratering event as partial and total impact melts which collected on the floor of the crater during the terminal stages of the event. The plains facies, with an estimated thickness of ~ 1 km and a volume of ~ 75000 km³, represent the most thoroughly impact melted materials which collected and ponded in the central portion of the crater floor. The corrugated facies, with an estimated thickness of ~ 1 km and a volume of ~ 180000 km³, represent impact partial melts mixed with debris. A relatively small volume of mare material was subsequently deposited in the basin (probably less than 25000 km³ in Mare Orientale).

There is little evidence that the basin has undergone major structural modifications subsequent to the terminal stages of the cratering event. The striking implication for the Orientale gravity anomaly is that mascon formation may be primarily related to crustal excavation and upwarping of a ‘moho’ plug, rather than attributable to post-impact mare filling.

The plains units on the floor of Orientale are similar to Cayley-like plains in other multi-ringed basins and on smaller crater floors. Impact melt deposits may therefore be a significant source of Cayley-like plains units.

The volumes of impact melt associated with the Orientale basin and their mode of deposition have important implications for petrogenetic models. Multi-ringed basin formation provides a mechanism for instantaneously melting large volumes of shallow to intermediate depth lunar crustal material which is emplaced such that the differentiation and crystallization of a variety of igneous rock types and textures may occur.

1. Introduction

The lunar Orientale basin is a 900 km diam circular topographic depression covering an area of over 700000 km² on the western limb of the Moon (Figure 1a, b). It is the freshest example of a class of lunar craters generally greater than 150 km in diam which form multiple concentric rings (Stuart-Alexander and Howard, 1970; Hartmann and Wood, 1971). The term basin refers to the topographic depression defined by the area inside the major scarp associated with the multi-ringed structure. In the case of the Orientale basin, it is the Cordillera Mountains (Figure 2) which define the major scarp, and thus the basin. The Carpathian-Apennine-Caucasus Mountains enclose the
Imbrium basin. These basin-defining scarps may or may not represent the original crater rim. The dark material which partially fills the topographic basins is known as mare. Thus, Mare Orientale is a flat, low albedo unit which partially floods and fills the Orientale basin (Figure 1b). Older examples of this type of basin include Imbrium, Serenitatis, Crisium, and Nectaris. There is general agreement on the placement and diameter of the multiple rings of the Orientale basin. There has been no agreement, however, on the placement and size of the original crater rim diameter, with estimates of 100 km (Van Dorn, 1968), 134 km (Van Dorn, 1969), 390 km (Baldwin, 1963; Hartmann and Yale, 1968; Short and Forman, 1972), 480 km (Baldwin, 1969) and 480 or 620 km (Hartmann and Wood, 1971). Understanding of the origin of multi-ring basins is extremely important to lunar studies because their ejecta deposits blanket the

Fig. 1a.

Fig. 1a-b. Orientale basin, about 900 km in diam. (a) Location map (Rükl, 1972). (b) Lunar Orbiter photograph. Portion of LO IV 194M.