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Calculation of ejecta thickness and structural uplift for Lunar and Martian complex crater rims.

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Crater rims of simple and complex craters have an elevation that is formed during the excavation stage of crater formation. For simple crater rims it is believed that the elevation is due to the sum of two equal parts, the thickness of the most proximal impact ejecta blanket (overturned flap) plus the thickness that results from plastic deformation including injection [1, 2, 3]. We intend to measure and quantify the kinematics of mass movements, especially concerning the question why complex impact craters have elevated crater rims like simple craters and precisely constrain the ejecta thickness and structural uplift of Lunar and Martian crater rims to understand what the main contributor to the elevated rim is [4]. We investigated a pristine 16 km-diameter unnamed Martian complex crater (21.52°N, 184.35°) and the lunar complex craters Bessel (21.8°N, 17.9°E) 16 km in diameter and Euler (23.3°N, 29.2°W) 28 km in diameter [5, 6]. In the crater walls of these craters we found columnar lavas on Mars and basaltic layering on the Moon. We used the uppermost layers of these exposed outcrops along the crater wall to determine the dip of the target rocks (Mars) and to distinguish between the bedrock and the overlying ejecta.

We precisely measured the structural uplift and ejecta thickness of these complex craters. The unnamed crater on Mars has a mean rim height of 375.75 m, with a structural uplift of 233.88 m (57.44%), exposed as columnar lavas and the superposing ejecta has a height of 141.87 m (43.56%). For the Lunar complex crater Euler the mean total rim height is 790 $\pm$ 100 m, with a minimal structural uplift of 475 $\pm$ 100 m (60 $\pm$ 10 %), exposed as basaltic layers [e.g., 7, 8] and a maximum ejecta thickness of 315 $\pm$ 100 m (40 $\pm$ 10%). The Lunar complex crater Bessel has a total rim height of 430 $\pm$ 15 m , with a minimal structural uplift of 290 $\pm$ 15 m (67 $\pm$ 3 %), exposed as basaltic layers and a maximum ejecta thickness of 140 $\pm$ 115 m (33 $\pm$ 3%). For the Martian crater, the calculated structural uplift has a value of 215.83 m [9]. For Euler and Bessel crater calculated values for the structural uplift are 310.76 m and 262.8 m, respectively [10].

The structural uplift of the crater rim only by dike injection and plastic deformation in the underlying target material seems unlikely at distances $\sim$1 km beyond the transient crater cavity. Other mechanisms, like reverse faulting, beginning in the excavation stage of crater formation, could be responsible for additional structural uplift of the crater rim. Nevertheless, our results show that structural uplift is a more dominant effect than ejecta emplacement for complex impact craters.

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