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Investigating the Origin of Dark Material on Vesta: Locations and Geological Context

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Deposits of dark material appear (DM) on Vesta's surface as lower-albedo features in the visible wavelength framing camera (FC) images returned by the Dawn spacecraft [1,2]. According to its geomorphological context DM can be divided into 3 major classes [3]: (1) material in impact craters, (2) DM associated with crater ejecta, and (3) clusters of dark spots and linear dark features. DM in impact craters occurs at different levels in crater walls and is subject to mass movement. Fans slumping down crater walls and DM on crater floors are the result of gravity-driven mass wasting triggered by steep slopes and impact seismicity. DM mixed with impact ejecta indicates that this material is excavated with together with the ejecta. Dark patches within crater ejecta might be due to local concentration of the DM either due to density and/or particle size differences in the ejecta plume, or due to the accumulation of ejecta behind large boulders, suggesting the DM has been excavated late in the cratering process. DM in the ejecta blanket also may explain the dark regions extending directly from the crater rim as an accu-mulation of ejected DM close to the rim that falls back into the crater by mass wasting. Some small craters expose continuous DM ejecta similar to lunar dark-halo craters, indicating that the impact excavated DM. Positive relief edifices containing DM were initially considered as potential volca-noes, but in higher-resolution images these appear more likely to be impact-sculpted hills, with DM associated with dark or dark-rayed impact craters, suggesting either an exogenic origin for the DM, or excavation and exposure of sub-surface dikes by impact erosion. Dark features inside and outside of craters are arranged in a linear orientation as outcrops along scarps or dark streaks crossing different topographies. The DM is distributed unevenly across Vesta's surface. Clustering occurs for all types of dark material expo-sure, and some craters expose or are associated with dark material, in con-trast to others in the immediate vicinity. This indicates local concentrations in the subsurface, rather than widespread distribution [3, 8].

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