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Double-layered ejecta craters on Mars: morphology, formation, and a comparison with the Ries ejecta blanket

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The ejecta blankets of impact craters in volatile-rich environments often show characteristic layered ejecta morphologies. The so-called double-layer ejecta (DLE) craters are probably the most confusing crater types showing two ejecta layers with distinct morphologies. A phenomenological ejecta excavation and emplacement model for DLE craters is proposed based on a detailed case study of the Martian crater Steinheim - a textbook like, pristine DLE crater - and studies of other DLE craters [1]. The observations show that DLE craters on Mars are the result of an impact event into a rock/ice mixture that produces large amounts of shock-induced vaporization and melting of ground ice. The deposits of the ejecta curtain are wet in the distal part and dryer in composition in the proximal part. As a result, the outer ejecta layer is emplaced as medial and distal ejecta that propagate outwards in a fluid saturated debris flow mode after landing overrunning previously formed secondary craters. In contrast, the inner ejecta layer is formed by a translational slide of the proximal ejecta deposits. This slide overruns and superimposes parts of the outer ejecta layer. Basal melting of the ice components of the ejecta volumes at the transient crater rim is induced by frictional heating and the enhanced pressure at depth. The results indicate similar processes also for other planetary bodies with volatile-rich environments, such as Ganymede, Europa or the Earth. The Ries crater on Earth has a similar ejecta thickness distribution as DLE craters on Mars [2]. Here basal sliding and fluidization of the ejecta increases outward by the entrainment of locally derived Tertiary sands and clays, that are saturated with groundwater.

References: [1] Wulf, G. & Kenkmann, T. (2015) Met. Planet. Sci. (in press); [2] Sturm, S., Wulf. G., Jung, D. & Kenkmann, T. (2013) Geology 41, 531-534.