THE INFLUENCE OF INTERIOR STRUCTURE AND THERMAL STATE ON IMPACT MELT GENERATION IN TERRESTRIAL PLANETS. L. Manske1,2, A.-C. Plesa1, T. Ruedas1,3, and K. Wünnemann1,2,
1Museum für Naturkunde, Leibniz Institut for Evoluton and Biodiversity Science, Berlin, Germany, (lukas.-manske@mfn.berlin), 2Institute for Geological Science - Freie Universität, Berlin, Germany, 3German Aerospace Center (DLR), Berlin, Germany.

Introduction: The production of melt and vapor is an important process during impact cratering events. We revisit the impact-induced melt generation during large scale impacts onto generic terrestrial planets.

Traditionally, so called scaling laws are used to estimate the amount of melt as a function of different impact parameters such as the impactor diameter $L$ and velocity $v$ as well as the densities of impactor $\rho_i$ and target $\rho_t$ and the internal energy of melting $E$. These scaling laws are derived from semi-analytical models and parameterized results from hydrocode simulations that account for melt generation due to the impact-induced shock (e.g., [1,2]).

However, there are two major issues with this approach; (i) The impactor and target density $\rho_i$, $\rho_t$ and internal energy of melting $E$ are assumed to be constant. While this is a valid assumption for small impacts, which encounter an essentially homogeneous target, scaling laws will fail if impact-related length scales such as the depth of penetration or the size of the shocked volume approach the length scales on which the properties of the target ($\rho_i$, $E$, $T$, $p$, etc.) change substantially (e.g., [4,5]). (ii) The latter choice is a limitation required by our use of parameterized thermal evolution models. These account for partial melting of the mantle and crustal growth [8,9] and consider the heat transport in both stagnant lid and plate tectonics regimes. The resulting heterogeneous planetary gradients are evaluated at different times to cover a broad range of the planetary evolution. These data are used as initial conditions for the target in the impact melt quantification models.

We investigate the dependence of melt production on impactor size $L$ (10 – 1000 km) and velocity $v$ (10 – 20 km/s) in vertical impacts ($\alpha = 90^\circ$). The latter choice is a limitation required by our use of 2D models in order to reduce computational costs. The target size varies from 0.5 – 1.5 Earth radii while the temperature $T$ is derived from the thermal evolution models, which in turn depends on the planet’s thermal history and size, specifically on the mantle thickness $d$ and gravity $g$. The latter in turn is a function of the mass of the target planet, which also influences the impact velocity and thus the depth of penetration of the impactor. While the models are derived for generic planets ranging in size from Moon-sized objects to super-Earths, they are also applied to planets of our Solar System, in particular Mars.
Results: Our preliminary results indicate that impact-induced melting is not only sensitive to shock-heating, which is the basis of most of the impact melt scaling laws, but also to decompression by uplifted material and heating due to plastic deformation. Figure 2 indicates the melt fraction (a) and the source mechanism of melt generation (b). Both panels show the melt at an identical time step. The left panel displaying the resulting melt distribution and the right panel the provenance of that melt.

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