FATE OF IRON CORES DURING PLANETESIMAL IMPACTS.

J. D. Kendall[1] and H. J. Melosh[2]
[1]Purdue University, West Lafayette, IN. (email: kendallj@purdue.edu), [2]Purdue University, West Lafayette, IN

Introduction: The exact fate of an iron core of an impacting planetesimal is not currently known. Recent research has shown that most of the Earth's mass accreted from already differentiated planetesimals with metallic cores[1]. For sufficiently large impacts, enough melt is formed to generate magma oceans[2]. The manner in which the metallic core of the impactor and the molten silicates of the magma ocean interact is not fully understood. This interaction will play a large role in our understanding of the formation of cores and the chemical composition of the mantle and core. Because the mantle of the Earth is abundant in siderophile elements[3], some chemical equilibration had to have occurred between the impacting cores and the target mantle. The exact conditions or combination of events through which this occurs is still not fully understood. Chemical equilibration between the silicate in the mantle and metal in the core will depend heavily upon the amount of melt and mixing during and after the impact. Chemical equilibration will become efficient for iron droplets broken down to a size of ~1 cm[4]. The most recent research has suggested the largest impacts with cores of size 10 km or more only partially equilibrate with the mantle due to low amounts of break up when sinking at terminal velocity[5]. However, these proposed models do not account for the interactions during the impact process. We have proposed a numerical model that will test the impact of a planetesimal with a differentiated iron core into a magma ocean that will determine what happens to the metal of the core and silicate mantle during an impact.

Methods: Our model utilizes iSALE, a 2D Eulerian hydrocode, to model hypervelocity impacts. The model simulates an impactor that has a differentiated iron core and an aluminum mantle. The target body is an aluminum surface with no strength. We chose aluminum because it has a good match to forsterite shock properties. We use the Tillotson equations of state for our model. We simulate 2D axisymmetric impacts of a sphere impacting a half-space. We also simulate a plane-strain cylindrical disk impacting a half-space. This allows oblique angles in 2D, commonly referred to as 2 ½ D impacts.

Conclusions: For an impact of a 20 km impactor with a 10 km diameter core at 11.5 km/s shown in figure 1, the amount of stretching experienced by the iron core is order of magnitude 10 times its original diameter. If we increase the velocity, this will also increase how stretched the iron core will be. By *t* = 100s after impact, the iron core has been spread across a 100 km by 50 km region. This is contrary to the current assumptions of an intact spherical core sinking at terminal velocity . Figure 1 shows what happens to an impact as time progresses and the iron core is further broken up. The iron core has been mixed into a 100 km by 100 km region by *t* = 1200s after contact.

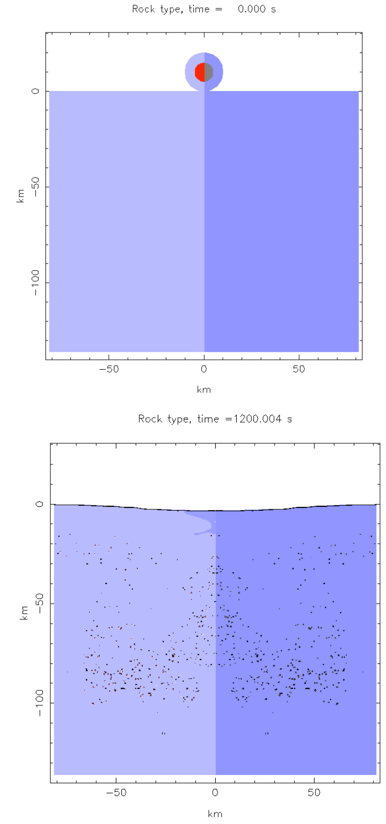

Figure 1: A 20 km iron core impactor with 11.5km/s velocity. The initial (top figure, prior to impact) and final stages (bottom figure, iron settling due to gravity) are shown. The blue represents the mantle material and the red/grey shaded regions is the location of the iron core material at each time.

Acknowledgements: This research is supported by NASA grant PGG NNX10AU88G.

References: [1] Yoshino, T. et. al. (2003) Nature, 422, 154-157. [2] Pierazzo, E. et. al. (1997) Icarus, 127, 408-423. [3] Murthy, V.R. (1991) Science 253, 303-306. [4] Rubie, D. et. al. (2003) EPSL 205, 239-255. [5] Dahl, T. and Stevenson, D. (2010) EPSL, 295,177-186.