Super-Earths Composition as a Signature of Planet Formation

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With the growing number of measured mass and radius for low-mass planets, we are beginning to see trends in the population. In particular, there is a spread in the Fe/Mg composition of planets that are thought to be rocky. Many planets are very iron-rich, while some are iron-poor. We set out to investigate if this spread in composition can be explained by the reprocessing that happens during collisions in the giant impact phase. We use an N-body code with more realistic collisions outcomes [1], that include debris production taken from parameterized smooth-particle hydrodynamic codes [2] used to investigate collisions. We focus on planets forming in the inner part of the disk (0.05 to 1 AU) to reproduce the locations where super-Earth planets are found so far. We track how planets grow starting from the end of the oligarchic phase to full fledge planets via giant impact collisions, as well as how the composition of these planets is modified during each collision. We include the effects of radiative processes depleting the smaller particles produced in the debris, as well as collisional grinding in the debris that can keep repopulating the small sized particles. Our results show that forming iron-rich planets like Mercury is possible but that planets with more iron, found in the super-earth data, are problematic.

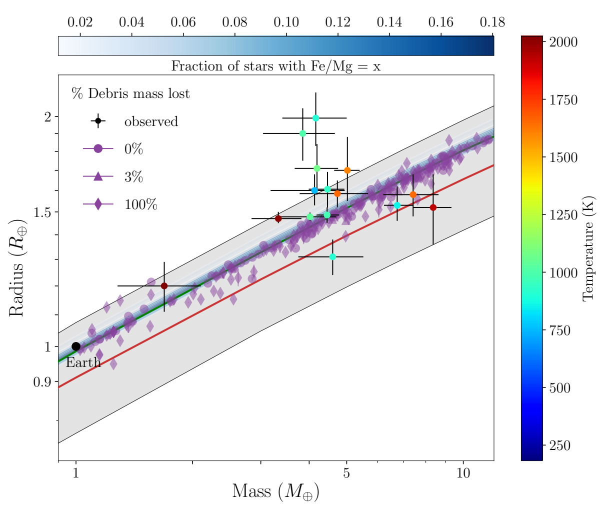

Figure. 1. Mass-radius of simulated super-Earths growing from giant impact collisions between differentiated embryos (purple). Planet results from different assumptions of debris mass loss are shown. Known super-Earths are shown colour-coded according to their equilibrium temperatures. Mass radius relationships from internal structure model [3] are shown for reference. Refractory ratios of Fe/Mg from stellar population are translated to mass-radius relations (blue) colour-coded according to the refractory ratio prevalence in the stellar composition (upper colour bar). The shaded grey region is the parameter space of rocky planets.

[1] Rubie, D. C. et al. (2015) *Icarus*, **248**, 89-108. [2] Leinhardt, Z. M., & Stewart, S. T. 2012, ApJ, **745**, 79-105 [3] Valencia, D. et al (2006) *Icarus*, **181**, 545-554.