Early cosmochemical fractionation through collisional erosion, a solution to the Enstatite Chondrite Earth model

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Early in the history of the Solar System, small planetary bodies accreted then grew to form the planets through energetic collisions. Some of these planetesimals suffered widespread chemical differentiation, through partial melting or fractional crystallization. Subsequent collisions and partial destruction of such differentiated planetesimals form non-chondritic planetary embryos. This process is expected to have a crucial importance on the final chemical composition of the terrestrial planets including the Earth. To quantitatively elucidate this effect, we report experimental results of low degrees of melting of Enstatite Chondrites as a function of pressure. Our results show that these partial melts are highly enriched in SiO_2, Al_2O_3 and Na_2O and depleted in MgO. On the other hand, fractional crystallization in a magma ocean and the formation of an albite-rich crust can also occur as suggested by the chemical trends in the Aubrites. Hence with either partial melting or fractional crystallization, a collisional erosion of differentiated crusts of reduced planetesimals will ultimately raise their Mg/Si ratio and decrease their content in incompatible elements. The differences in composition between the BSE and the EH can be reconciled with this major event which can also account for the observed interactions between chondrules and Na-rich SiO gases.