Core-merging giant impact and its influence on core-mantle structure and chemistry of a terrestrial planet

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The formation of terrestrial planets in the inner solar system is dominated by a series of large or giant impacts from planetesimal to embryo-sized bodies. A special type of giant impact, the core-merging giant impact (CMGI), can significantly affect the core formation and the extent of core-mantle chemical equilibrium, but has been generally ignored by assuming its low occurring possibility. During a CMGI, the impactor's core would be wrapped by its own mantle materials and then merge with the target's core directly. The impactor's core hence has no chance to be reacted with the target's mantle. Therefore, it will change the extent of core-mantle equilibrium significantly.

About 800 smoothed particle hydrodynamics (SPH) simulations are performed to find out the conditions for occurrence of CMGI at different accretion stages (e.g., from Moon-like size to current Earth's size). Then a Monte Carlo simulation including all the conditions of giant impact is performed to find out the occurring chance of CMGI. We find that there is about 7 to 13% of core materials is directly originated from CMGI. A very interesting finding is that there are pieces of silicate mantle can be brought into the center of core briefly. Then they will be quickly ejected out of core due to the deficit of density. They will somehow react with iron liquid and stay at the core-mantle boundary. We suggest that this is a possible origin of ULVZ (ultra-low velocity zone). Our hypothesis has three predictions: 1) ULVZ must be very old, even older than the age of Moon; 2) ULVZ can be contaminated by core materials and hence possesses with some strange signals only can be found in the core; 3) ULVZ can be found in other terrestrial planets even those without plate-tectonic movements.