The core-merging giant impact and its influence on ULVZs and Earth's lower mantle

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Earth was formed by a series of giant impacts from planetesimals to embryo-sized bodies. A special type of giant impact, which we define it as the core-merging giant impact (CMGI), has not been carefully studied. For a CMGI, the impactor's core is wrapped by its own mantle and will be directly delivered into Earth's core without any contact with Earth's mantle in our giant impact simulations. During such core merging process, not only the metallic core of impactor but also a small part of lower silicate mantle will be brought into proto-Earth's core. At the same time, a lot of impactor's mantle will stay in Earth's lower mantle.

ULVZs are anomalous regions which located at the bottom of Earth's mantle with a significant decrease of seismic velocity and increased density (i.e., >10% difference), and its range is about 5-40km. People believe that ULVZs is made up of a unique iron-rich material and may or may not be partially molten. But the origin of such iron-rich material is still controversial. The existing hypotheses about the formation of ULVZs include partial melting, core-mantle reaction, core crystallization (exsolution), subducted banded iron formations or other slab materials, subducted hydrous minerals and then reacted with metallic core.

For a CMGI, the impactor's mantle would be brought into Earth's core and react with metallic core. Those silicates came back quickly to CMB due to the density deficit. During the stay in the core, they would react with iron-nickel liquid by some degree under such extremely high temperature and pressure. Recent melting experiments on Fe-Si-O-Mg quaternary alloys at core condition show that SiO_2-MgO-FeO melts can be produced, which are dense and can keep stable on CMB.

The impacor's siliacte mantle which stay in Earth's lower mantle must be compositionally-distinct from the surrounding mantle. These anomalous mantle may cause the large-scale heterogeneity of Earth's lower mantle.