Title: The Initial State of Earth's Mantle after the Moon-Forming Impact

Abstract:
The standard giant impact hypothesis suggests that the Moon formed out of a debris disk created by a collision between an impactor and the proto-Earth. This model can successfully reproduce several observed features, but cannot explain the identical isotopic ratios between the Earth and Moon. This is because most of the disk materials come from the impactor which presumably had different compositions from the Earth. Recently suggested impact models, which are more energetic than the canonical model (Ćuk & Stewart 2012; Canup 2012), may overcome this problem since the disk materials originate from the Earth. However, an additional constraint that arises from the Earth may need to be considered. Geological studies indicate that the Earth's mantle has never been mixed, not even by the giant impact (e.g., Touboul et al. 2012). To identify the initial state of the Earth's mantle, we perform giant impact simulations with a perovskite equation of state (Stixrude et al., 2009; de Koker and Stixrude, 2009). We find out that the mantle stays unmixed in the standard model while it may get mixed in the energetic impact models due to its large impact energy. This outcome may become a challenge for these energetic impact models.