Continental growth, crustal recycling, and global water cycle

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The evolution of continental crust provides first-order control on Earth’ s surface environment, but relevant studies on this important issue have long been in a confused state since 1990s. There are mainly two reasons for this situation. First, the volume of the global database of detrital zircons has been continuously growing in the last three decades, and as a result, the most of new crustal growth models have been built solely on such a zircon database. Zircons that have survived to the present day, however, do not constrain the amount of crust that has been lost to the mantle by subduction, so there is no way to reconstruct net crustal growth from zircon data. Second, this situation further deteriorated by two influential papers, Belousova et al. (2010) and Dhuime et al. (2012), with the former introducing an illogical method of using zircon age data to construct a growth model, and the latter claiming falsely that this method can actually reconstruct net crustal growth. The situation has recently been rescued by the development of a sensible method of utilizing zircon age data as well as a new geochemical box modeling of Nd isotope data. These new studies point to the possibility of rapid crustal growth and efficient crustal recycling in early Earth, and such crustal evolution is consistent with the operation of plate tectonics throughout Earth history. In particular, the secular evolution of crustal recycling, when considered jointly with the constancy of continental freeboard, indicates a novel connection between global water cycle and the stability of continental crust, which can naturally explain both the Hadean/Archean and Archean/Proterozoic transitions.

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