Results from the Mission to Really Early Earth (MtREE): Continental Crust and Plate Tectonics by 4.50-4.35 Ga?

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Although the first 500 Ma of Earth evolution was surely the most geodynamically vigorous in our planet's history, little is known about the Hadean Eon due to the lack of a rock record. How then do we gain insight into the most formative stage of Earth evolution? We have begun to glean information regarding the Hadean from detrital zircons as old as 4.38 Ga from Jack Hills, Western Australia, including $\delta^{18}O$ results indicating the presence of surface water by 4.3 Ga, and Xe isotopic data that define the initial terrestrial Pu/U, a parameter key to understanding the origin of the atmosphere. The Mission to Really Early Earth is continuing $^{207}Pb/^{206}Pb$ age analyses of Jack Hills zircons using a rapid ion microprobe survey method. The over 40,000 zircons thus far age characterized have yielded ~1300 precisely U-Pb dated >4 Ga zircons, and their investigation continues to provide new constraints on the earliest evolution of the atmosphere, hydrosphere, and lithosphere. $^{176}Hf/^{177}Hf$ analyses indicate large $\varepsilon_{Hf(T)}$ deviations from CHUR. Positive $\varepsilon_{Hf(T)}$ deviations between 4.35-4.20 Ga imply a depleted reservoir with Lu/Hf up to 0.08 and negative values in the same age interval are consistent with the formation of significant continental crust by ~4.5 Ga. Zircon thermometry establishes the existence of wet, minimum-melting conditions throughout the Hadean. All data obtained to date indicate that by 4.35 Ga, the Earth had settled into a pattern of crust formation, erosion, and sediment recycling similar to that produced during the known era of plate tectonics.