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Onset of giant planet migration at ca. 4480 Ma

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Immediately after their formation, the terrestrial planets experienced intense impact bombardment by comets, planetesimals and asteroids. This late accretion thermally modified their solid surfaces, and may have impeded life's origin on the Hadean (pre-3.85 Ga) Earth. The sources and tempo of this early bombardment, however, are still uncertain. Here we present a timeline that relates variably retentive radiometric ages from asteroidal meteorites, to new dynamical models of late accretion and of giant planet migration. Reconciliation of the geochronological data with dynamical models shows that giant planet migration leads to an intense ∼30 Myr influx of comets to the entire solar system. The absence of whole-sale crustal reset ages after ∼4450 Ma for the most resilient chronometers from Earth, Moon, Mars, Vesta and various meteorite parent bodies confines the onset of giant planet migration to no later than ca. 4480 Ma. Waning impacts from leftover planetesimals, asteroids and comets continue to strike the inner planets through a monotonic decline in impactor flux, in agreement with predictions from crater chronology. Amended global 3-D thermal analytical models derived from our new impact mass-production functions further demonstrate that persistent niches for prebiotic chemistry on the early Hadean Earth could endure late accretion bombardments since at least 4400 Ma.