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Did Mars witness the birth of Jupiter?

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Nucleosynthetic isotopic anomalies in several major elements – expressed in Δ17O, ε48Ca, ε50Ti, ε54Cr, ε64Ni, ε92Mo, ε100Ru, and μ142Nd notations – point to ties between the terrestrial planets and their meteoritic building blocks[1]. Terrestrial rocks show anomalies that imply the first half of Earth's accretion consisted mostly of material akin to dry, reduced enstatite chondrites (EC), with a smaller fraction of moderately volatile, oxidized ordinary chondrites (OC), and a minor component of volatile-rich carbonaceous chondrites (CC). The latter half of its formation, however, was deprived of both OC and CC[2]. This sequence of assembly contradicts conventional dynamical models of terrestrial planet formation because the feeding zones of the terrestrial planets gradually increase over time[3]. Here we investigate whether Mars experienced a similar accretion history.
We run a Monte Carlo mixing experiment wherein the isotopic composition of Earth and Mars are a combination of enstatite (EC), ordinary (OC), CI and CO+CV carbonaceous chondrites [2]. We report that Earth is a mixture of (78%$\pm$21%) EC + (17%$\pm$10%) OC + (4%$\pm$2%) CC (χ2 $\sim$ 6)[4,5,6]. The first half of Earth's accretion has about 30% OC but the latter half is devoid of OC and CC. Mars consists of (59%$\pm$15%) EC + (39%$\pm$27%) OC + (2%$\pm$1%) CC (χ2 $\sim$ 7), with the CC portion being almost exclusively CO+CV. This compares favourably with a previous estimate of 45% EC + 55% OC[7]. Mars' first half of its accretion comprises $\sim$60% OC, which gradually decreases with time. Even though the last $\sim$0.8% of Mars' accretion[8] may have come from a single large impact as late as ca. 4.43 Ga[9] it appears that the (gradual) cessation of OC accretion occurred within a few million years because Mars formed in about 5 Myr after CAI[10]. The most efficient mechanism to severely deplete the OC reservoir is by ejecting it out of the solar system via encounters with Jupiter. We thus compare our Monte Carlo results with those expected from Grand Tack N-body simulations of terrestrial planet formation and find good agreement.
Key result: The difference between the accretion histories of Earth and Mars was most likely caused by the formation and migration of Jupiter, which subsequently deprived the inner solar system of OC relative to EC.

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