What is Mars' accretion history?

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Introduction. The accretion history of Mars is currently poorly constrained. Recent N-body simulations indicate its composition could consist of roughly equal portions of material akin to dry, reduced enstatite chondrites (EC) and moderately volatile, oxidized ordinary chondrites (OC), assuming the former resides closer to the Sun than the latter, but the uncertainties are large enough that Mars' composition nearly spans the whole spectrum [1]. The large compositional heterogeneity is the result of a diverse dynamical pathway from its formation to its current orbit through possible interaction with Jupiter. The gas giant formed before dissipation of the protoplanetary disk, presumably in the first ~4 Myr of solar system formation. While nebular gas was still present, Jupiter may have migrated inwards and tacked at 1.5 AU. Simultaneously Saturn formed and the two planets entered in a 3:2 resonance and reversed their migration [2]. This migration excited planetary building blocks in the inner solar system, resulting in extensive mixing and planetesimal removal. The chronology of Mars' formation indicates that it accreted while Jupiter formed [3]. The goal of the present study is to evaluate how the formation and migration of Jupiter influenced the nature of the material accreted by Mars. Isotopic anomalies of elements with different siderophile behaviour convey clues on the nature of the material accreted by the terrestrial planets through time [4].

Methods We run a Markov Chain Monte Carlo mixing experiment wherein the isotopic composition of Earth and Mars result from a combination of enstatite (EC), ordinary (OC), CI and CO+CV carbonaceous chondrites [4]. Error analysis is done via the Metropolis-Hastings algorithm [5].

Results We report a best-fit composition of Mars that consists of 65% EC + 35% OC by mass. Unfortunately, the precision of isotopic analyses on martian samples are for the most part too imprecise to definitely test model predictions and are in agreement with most earlier predictions of its composition.

Key message We call for new measurements of isotopic anomalies in SNC meteorites targeting siderophile elements (most notably Ni, Mo and Ru) to constrain Mars' accretion history and its formation location.

References: [1] R. Brasser et al., (2017). *EPSL* **468,** 85. [2] K. Walsh et al. (2011). *Nature* **475**, 206. [3] N. Dauphas & A. Pourmand (2011). *Nature* **473**, 489. [4] N. Dauphas (2017). *Nature* **541**, 521. [5] N. A. W. Metropolis et al. (1953). *J. Chem Phys* **21**, 1087