The implications of a non-chondritic terrestrial Mg isotope composition

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There has been much interest generated from the observation that the Earth has non-chondritic ^{142}Nd/^{144}Nd. This has led to a renewed search for hidden reservoirs or means to accrete a fractionated Earth. In this quest, the ^{146}Sm-^{142}Nd isotopic system has the advantage of providing chronometric constraints on the events that resulted in the non-chondritic ^{142}Nd/^{144}Nd, but suffers from being hosted in a trace element system. As such, the volume represented by the missing reservoir, whether hidden in the deep Earth or previously lost to space, is unknown. In contrast, major elements, that represent stoichiometric components of the main minerals comprising the mantle, yield important information on the size of any missing reservoir. This has been the impetus behind our examining the magnesium isotope ratio of the Earth and chondrites. We are not the first to attempt to compare the ^{26}Mg/^{24}Mg of the Earth to chondrites, but studies to date show marked disparity in results. To address these divergent measurements, we have developed a new methodology of critical mixture double spiking, to generate high precision measurements (±20ppm) that should also be comparably accurate. Using this approach we document that the Earth is ~50ppm isotopically heavier than chondritic meteorites in ^{26}Mg/^{24}Mg. We have also undertaken density functional calculations of magnesium isotope fractionations between phases likely to crystallise in a deep, terrestrial magma ocean. Removal of manesium-perovskite can result in sufficient fractionation of Mg in the residual liquid to account for the heavy Mg isotope composition we have measured in accessible terrestrial samples. However, this would require a hidden reservoir that represents ~1/3rd of the total volume of the mantle. We will discuss the implications of these findings for the formation and evolution of the Earth, exploring the relative plausibility of hidden versus missing reservoirs.