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The Mg isotope budget of the modern ocean: Constraints from riverine Mg isotope ratios

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We have measured the Mg isotope isotope ratios in 39 of the world's largest rivers. The rivers cover a range of geologic, tectonic and climatic drainage basin environments. The rivers analysed constitute 50% of the global Mg riverine flux to the oceans. The range in riverine δ^{26}Mg is 2.5 per mil, half the variation in terrestrial rock. Although the Mg isotopic composition of the source rock can be important for small rivers, at a global scale lithology is of limited significance for Mg isotope ratios in rivers. At least part of the variability at a global scale can be attributed to fractionation in the weathering environment. A flux weighted Mg isotope composition of global runoff has been estimated at -1.09 per mil relative to the DSM3 standard. Even taking into account uncertainty, this is distinct from seawater at -0.82 per mil. This difference arises either from the fractionation of Mg isotopes in the ocean or a Mg budget which is not in steady state. The difference is consistent with fractionation by carbonate precipitation. In the simplest steady state scenario, where the oceanic mass balance is maintained by riverine input and hydrothermal and dolomite output, Mg isotope ratios imply a minimum dolomite Mg flux of 9% of the total output Mg flux and 91% hydrothermal. This is greater than some previous estimates of the dolomite flux.