Variations in triple oxygen isotopes in precipitation and river waters in the continental U. S.

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The triple oxygen isotope composition of water is an emerging tool in studies of hydrological processes because the $\delta^{18}O$-$\delta^{17}O$ relationship differs during kinetic and equilibrium isotope fractionation such that ^{17}O-excess is sensitive both to humidity at the site of evaporation and to secondary processes during moisture transport [1]. The utility of triple oxygen isotope measurements in hydrological studies is twofold: 1) they provide additional contraints on isotopic fractionation of precipitation when both ^{17}O-excess and *d-excess* can be measured and 2) they provide an additional understanding of hydrologic processes, such as evaporative effects, that are recorded in oxygen bearing minerals (*e.g.*, $CaCO_3$, SiO_2) and traditionally investigated with $\delta^{18}O$ alone.

Most ^{17}O-excess paleoclimate studies are based on high-latitude ice core records [2,3], but there is great potential to apply triple oxygen isotope approaches to climate proxies in low- to mid-latitude settings. A better understanding of ^{17}O-excess in meteoric waters in these settings is thus needed to develop ^{17}O-excess as a tool for probing the modern, past and possibly future hydrological cycle. Here we report ^{17}O-excess values of meteoric waters from the continental U.S. ^{17}O-excess values in weekly precipitation samples vary between -0.01‰ to +0.05‰. The lowest ^{17}O-excess values are from precipitation sourced in the Gulf of Mexico, whereas the highest observed ^{17}O-excess values are from precipitation that originates in the nothern Pacific Ocean. ^{17}O-excess values of surface waters are similar to or lower than those of precipitation in the main recharge season. We use our results to demonstrate the role of moisture source, transport effects, and post-precipitation processes on continental-scale ^{17}O-excess variation and to provide a framework for using triple oxygen isotope records as proxies for hydrological change.

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The Formation of the Cores of the Giant Planets

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It is ironic that the most massive planets in the Solar System had to have formed in the least amount of time. Jupiter and Saturn, for example, which are made mainly of hydrogen and helium, must have accreted this gas before the solar nebula dispersed. Observations of young star systems [1,2] show that gas disks, at least insofar as they are traced by the presence of dust, as well as accretion onto the star, have lifetimes of ~1-10 Myr. So, the gas giant planets had to form before this time.

Thus, one of the most challenging problems we face in our understanding of planet formation is how Jupiter and Saturn could have formed so quickly. In the core accretion model, which envisions that a large planetary embryo formed first by two-body accretion followed by a period of inflow of gas directly onto the growing planet [3,4], the main difficulty is in the first step. The accretion of a massive atmosphere requires a solid core ~10 M Earth-masses in mass [5,4,6].

We will present the most complete models of standard core formation to date and show that it is difficult to construct objects larger than ~2 Earth-masses before the disk dissipates [7]. We will also present some new simulations that include solutions that have previously been suggested, but to have yet been included in full simulations. These include planetesimal-driven migration [8] and pebble accretion [9].

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