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The third isotope of the third element on the third planet

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Abstract

The third isotope of the third most abundant element, ^{17}O, records indispensible information on the origin and operation of Earth, the third planet. The measured uniformity in fractionation of ^{16}O, ^{17}O, and ^{18}O in rocks and minerals over the whole of geologic time, from Hadean to Quaternary, records the existence of a global magma ocean prior to the formation of continents. New techniques of high-resolution mass spectroscopy and of femtosecond X-ray diffraction are leading toward a deep understanding of the origin of kinetic isotope fractionation effects during metabolism. Analysis for the rare molecule $^{17}O^{18}O$, distinguished by the substitution of two heavy isotopes, in combination with data on $^{18}O^{18}O$, provides an insight into the mechanism whereby plants produce oxygen. Given the skills of *American Mineralogist* readers in three-dimensional visualization of complex crystalline and molecular structures and the talents of biogeochemical colleagues in measuring isotope fractionation by organisms in nature, there is every reason to expect extraordinary advances in understanding the cycling of life's elements, H, C, N, O, and S between the biosphere, atmosphere, hydrosphere, and lithosphere.

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