Low Mid-Proterozoic Atmospheric Oxygen Levels?

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Earth's ocean-atmosphere system has undergone a dramatic but protracted increase in oxygen. This environmental transition ultimately paved the way for the rise of multicellular life and provides a blueprint for how a biosphere can transform a planetary surface. However, estimates of atmospheric oxygen levels for large swaths of Earth's history still vary by orders of magnitude—foremost for Earth's middle history. Rare oxygen isotope systematics provide a means to track atmospheric isotopic signatures and thus potentially provide more direct estimates of atmospheric oxygen levels through time than traditional approaches. Oxygen isotope signatures that deviate strongly from the expected mass-dependent relationship between develop during ozone formation, and these 'mass-independent' signals can be transferred to the rock record during oxidation reactions in surface environments that involve atmospheric O_2. The magnitude of mass-dependent signals is dependent upon pO_2, pCO_2, and the overall extent of biospheric productivity. Here, we use a stochastic approach to provide a new estimate of atmospheric pO_2 from the mid-Proterozoic $\Delta^{17}O$ record, relying on the fact that pO_2 and biospheric productivity must be coupled in order to limit redundancy in our inversion results. Using this approach we find strong evidence for atmospheric oxygen levels less than ~1% of the present atmospheric level (PAL) for at least intervals of the mid-Proterozoic.