Laughing Gas Could Have Helped Warm Early Earth

C.L Stanton et al., *Geobiology,* 22 August 2018. https://doi.org/10.1111/gbi.12311

Ancient, iron-rich seas could have fueled robust production of nitrous oxide, a potent greenhouse gas better known as a dental sedative—thus helping to reconcile how the young planet remained ice-free when the sun was much dimmer.

JENNIFER GLASS OF GEORGIA TECH HOLDING STROMATOLITIC IRONSTONE (above and inset below). Credit: Georgia Tech / A. Carter

BANDED IRON FORMATIONS IN KARIJINI NATIONAL PARK, AUSTRALIA. These sediments, once ancient seafloor, are red because iron rusted out of solution as oxygen built up in the water. The same dissolved iron facilitated production of nitrous oxide. Credit: Georgia Tech / J. Glass

INNOVATION | Carbon dioxide and methane get partial credit for keeping the early Earth ice-free, but established research suggests those gases were not always sufficiently abundant to warm the globe on their own. New views on ocean chemistry during Proterozoic Eon, ~2.4-0.5 billion years ago, reveal a new way that nitrous oxide could have filled this 'greenhouse gap.' A non-biological process known as chemodenitrification produces nitrous oxide only when seawater is high in dissolved iron and low in oxygen, a condition now widely hypothesized for the Proterozoic oceans.

DISCOVERY | In lab experiments testing chemodenitrification, ferrous iron dissolved in seawater reacted with nitrogen molecules to yield unusually high fluxes of nitrous oxide. Plugging these higher fluxes into a photochemical model of the Proterozoic atmosphere, assuming oxygen at only 10 percent of present atmospheric level, yielded concentrations of nitrous oxide 10 times greater than today's—plenty to provide a hearty boost to the greenhouse effect.

RELEVANCE | Understanding how our planet regulates climate in the modern era and in the distant past is critical for explaining the long-term maintenance of planetary habitability on early Earth and Earth-like worlds beyond our solar system.

ALTERNATIVE EARTHS