ATMOSPHERIC CHEMISTRY

Isoprene and agriculture

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Growing demands for food and biofuels have led to the conversion of grasslands and forests to agricultural land. The associated changes in plant type affect the magnitude of isoprene emissions from vegetation, and lead to enhanced levels of surface ozone at a local level, numerical simulations suggest.

Catherine Hardacre, of the University of Edinburgh, and colleagues constrain the effect of projected changes in land use on plant isoprene emissions in the first half of the twenty-first century, using a broad range of land-use scenarios and a biogenic volatile organic compound emissions model. They find that the cultivation of biofuel crops — which emit large quantities of isoprene — in the Northern Hemisphere leads to a rise in emissions. In contrast, the replacement of isoprene-emitting forest and grasslands with food crops, particularly in Brazil and sub-Saharan Africa, reduces emissions. By 2030, the global isoprene load could increase by up to 1.4%, or decline by up to 1.7%, depending on the balance of these changes.

Chemistry transport modelling suggests that at the global scale, the projected changes in isoprene emissions have only a minimal effect on levels of the surface pollutant ozone, a product of isoprene oxidation. However, significant increases in surface ozone concentrations are evident at a local level, particularly in North America, China and boreal Asia. *AA*

TECTONICS

High turnover

Geology http://doi.org/md8 (2013)

Crustal recycling probably peaked about 1.1–1.2 billion years ago, according to geochemical analyses of magmatic rocks from across the globe.

Martin J. Van Kranendonk at the University of New South Wales, Australia, and Christopher Kirkland at the Geological Survey of Western Australia assessed the concentrations of the elements zirconium and thorium from rocks in Western Australia. They combined their results with a database of elemental abundances and oxygen isotope values of grains of the mineral zircon from around the world. The data show that the concentration of these elements and oxygen isotope values — geochemical markers of crustal recycling — began to rise about 3 billion years ago. The indicators peaked around 1.1–1.2 billion years ago, coincident with the assembly of the supercontinent Rodinia. At that time, tectonic plates were already large, but the mantle was warmer and convection was probably faster. The plates drifted across the Earth at faster rates, leading to unprecedented rates of crustal recycling and a climax in continental collisions.

The subsequent cooling of the Earth's mantle slowed the drift of the plates, limiting rates of plate collision and crustal recycling. *AW*

PLANETARY SCIENCE

Core merger

Icarus **226,** 20–32 (2013)

It has been proposed that a giant impact occurred in the first 500 million years of Mars's history. Numerical modelling of the proposed impact's aftermath suggests that the metallic cores of the impactor and Mars would have merged, producing thermal gradients in the deep martian interior that could have driven a short-lived core dynamo.

Julien Monteux at Université de Nantes, France, and colleagues used numerical models to explore the dynamics and thermal effects of metallic iron from an asteroid sinking through the martian mantle to merge with the core. In the simulations, material from the impactor heats the surrounding mantle as it sinks, altering the thermal structure of the martian interior. The core merging would have occurred within a million years after the impact. Because the added heat is mixed into the core, the heat flux across the core–mantle boundary could have been enhanced. This heat-flow in turn could have driven a dynamo that persisted until the added heat had dissipated, over a period of about 100 million years.

However, depending on how the heat from the impactor was mixed into the core, core merging may have also weakened or even inhibited a pre-existing dynamo. *TG*

PALAEOCLIMATE

Sea-ice effects

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During the Pliocene warm period 3 million years ago, Arctic temperatures were 10–12 °C warmer than today, far greater than the mean global temperature difference of only 2–4 °C. This polar amplification could be related to the loss of sea ice in the Arctic Ocean, according to model simulations.

Ashley Ballantyne of the University of Montana, USA, and colleagues used an atmosphere–ocean general circulation model to assess the role of sea ice in Arctic temperatures during the Pliocene warm period, when atmospheric CO_2 concentrations were similar to today. Their simulations without sea-ice formation in the Arctic Ocean best matched proxy-based temperature reconstructions for the high northern latitudes. In these simulations, the lack of sea ice promoted atmospheric convection over the ocean, increasing atmospheric water vapour content and cloud formation. Moreover, these simulations also showed a reduction in seasonal temperature variations in the Arctic, consistent with some observational data.

The researchers note that their ice-free simulation slightly overestimates the temperature response relative to the proxy reconstructions, suggesting that Arctic climate patterns during the mid-Pliocene may be best explained by the loss of most, but not all, winter sea ice. *AN*

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