HYDROGEOLOGY

Mantle vents

Geology http://doi.org/ks2 (2013)

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Geothermal springs in the Rocky Mountains of the western United States often occur along faults. Geochemical analyses of the spring water show the combination of faults and springs form vents that allow gases from the underlying mantle to be released at the surface.

Karl Karlstrom at the University of New Mexico, Albuquerque, USA, and colleagues analysed the carbon dioxide and helium isotopic signature of waters collected from 25 geothermal springs in the Rocky Mountains. The ratio of primordial isotope ^{3}He to the radiogenic ^{4}He in the waters indicates that these gases, as well as a significant fraction of the carbon dioxide dissolved in the waters, come from Earth's mantle. The researchers suggest that gases escaping from the mantle move upwards through faults and fractures in Earth's crust, then become dissolved in groundwater, and are finally vented at the surface as geothermal spring waters.

The results show that mantle degassing is surprisingly widespread and persistent, and that hot springs facilitate degassing of mantle volatile gases even in the middle of continental plates such as North America. *AW*

BIOGEOCHEMISTRY

Deep-sea carbon fix

Glob. Biogeochem. Cycles http://doi.org/ks3 (2013)

Deep-sea microbial communities convert inorganic carbon into organic matter, fuelling benthic ecosystems, but the magnitude of this conversion — and the identity of the microbes responsible — remains uncertain. Measurements in marine sediments suggest that primitive, single-celled organisms known as archaea contribute significantly to this carbon fixation at the sea floor.

Antonio Dell'Anno of the Università Politecnica delle Marche, Italy, and colleagues monitored the rates of carbon fixation (the transformation of inorganic carbon into organic matter) in marine sediments collected from the Iberian margin in the Mediterranean Sea and northeastern Atlantic Ocean. On average, inorganic carbon fixation accounted for 19% of the biomass produced by seafloor microbes, with the rest presumably derived from sinking organic matter. The findings suggest that inorganic carbon fixation helps to sustain deep-sea food webs.

An analysis of the microbial community composition in the sediments revealed a positive association between archaeal abundance and rates of inorganic carbon fixation, suggesting that archaea are key contributors to carbon cycling in the deep sea. Indeed, the researchers' selective inhibition of archaeal metabolism resulted in the complete inhibition of inorganic carbon fixation. *AA*

ATMOSPHERIC CHEMISTRY

Early oxidation

Earth Planet. Sci. Lett. **366,** 17–26 (2013)

During the Great Oxidation Event 2.4 billion years ago, oxygen levels in the Earth's atmosphere rose dramatically. Sulphur isotope data suggest a flux of oxygen into the atmosphere some 300 million years earlier.

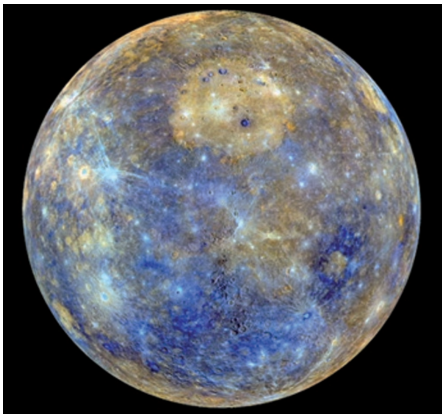
Florian Kurzweil of Westfälische Wilhelms-Universität Münster and colleagues measured multiple sulphur isotopes in shales found in Ontario, Canada, that formed 2.71 billion years ago. A photochemical model of the Archaean atmosphere including these sulphur isotope values simulates a transition from a hazy, methane-rich atmosphere to an increasingly oxidative one 2.7 billion years ago, as oxygen production outpaced the creation of methane. This allowed oxygen to persist in the atmosphere, albeit at levels far below those seen during the Great Oxidation Event some 300 million years later.

The authors attribute the production of oxygen to a pronounced expansion of bacteria capable of producing oxygen through photosynthesis. Furthermore, weathering of fresh volcanic rock was enhanced at this time, which would have delivered nutrients to the oceans to fuel photosynthesis. *AN*

PLANETARY SCIENCE

Churning Mercury

J. Geophys. Res.
http://dx.doi.org/10.1002/jgre.20049 (2013)



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Evidence for extensive volcanic activity on the surface of Mercury is at odds with suggestions that its mantle is too thin to sustain the long-lived convection needed to produce magmas. Numerical models, however, demonstrate that mantle convection can persist in a thin mantle and generate broadly distributed magmas on Mercury.

Nathalie Michel at Case Western Reserve University, USA, and colleagues used a mantle convection model to simulate the global thermal evolution of Mercury from its formation to the present day. They explored a range of possible scenarios within the geological, geochemical and geophysical constraints from data obtained by the spacecraft MESSENGER, which has orbited Mercury since 2011. The simulations show that sustained mantle convection was possible over much of Mercury's history, even if the mantle was as thin as 300 km, roughly 12% of the planet's radius.

Calculations of magma generation based on the results of the convection model show that high degrees of melting should have occurred early in Mercury's history. Also, volcanic activity could plausibly have occurred as late as one billion years ago, consistent with observations of Mercury's surface. *TG*

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