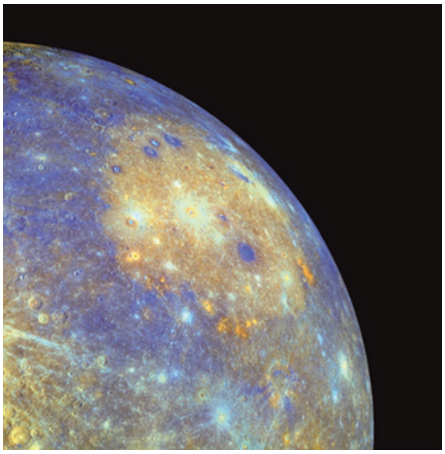
PLANETARY SCIENCE

Saving sulphur

Earth Planet. Sci. Lett. **394,** 186–197 (2014)



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The relatively high abundance of sulphur detected on the surface of Mercury suggests that the processes that operated during the separation of the planet's metal-rich interior into the core and the mantle and crust may be different from other terrestrial planets. Laboratory experiments suggest that the formation of sulphide minerals as Mercury's molten interior cooled may have kept sulphur and iron from being swept entirely into the planet's core.

Valérie Malavergne at the Université Paris Est Marne La Vallée, France, and colleagues melted samples of synthetic meteorites thought to be analogous to the building blocks of Mercury under pressure and temperature conditions that are believed to have occurred when the interior of the planet differentiated into the mantle and core. As the molten silicate cooled, sulphide minerals rich in magnesium and iron formed. At shallower depths, calcium-rich sulphides crystallized. The team proposes that the crystallization of magnesium- and calcium-rich sulphides, whose low density makes them unlikely to sink into the core, could result in the retention of sulphur and iron in the mantle and crust.

Compositional data from the MESSENGER orbiter lend further support to the idea that sulphur, iron and calcium are mostly stored as sulphides at Mercury's surface. *TG*

CLIMATE CHANGE

Walker uncertainty

Clim. Dyn. http://doi.org/r86 (2014)

Climate models have forecast that the Walker atmospheric circulation cell over the Pacific Ocean should weaken and move eastwards, but recent observations show the cell strengthening and shifting to the west. Analyses of numerical model simulations and observational data suggest that this recent behaviour could be the result of the recent predominance of La-Niña-like conditions in the Pacific region.

Tobias Bayr of GEOMAR, Germany, and colleagues used the CMIP3 and CMIP5 climate models to assess past and potential future changes in the Pacific Walker circulation cell from 1950 to 2100. The models project either strengthening or weakening of the Walker circulation over the Pacific, but all simulate an eastward shift relative to the 1950–1979 average, in contrast to observed trends. The difference between the models and observations seems to arise from the projected mean state of the equatorial Pacific Ocean. During periods when on average the eastern Pacific is anomalously cool and the western anomalously warm — analogous to the recent La-Niña-like conditions — the circulation is stronger and shifts westwards.

However, mean conditions more analogous to El Niño events, such as the projected trend for 2070–2100, favour a weakening and eastward shift of the circulation. *AN*

GEODYNAMICS

Mantle stages

J. Geophys. Res. http://doi.org/r87 (2014)

Questions surround the timing of the onset of Earth's mantle convection and its subsequent evolution. Numerical modelling suggests that the mantle developed in two distinct stages.

Masaki Ogawa at the University of Tokyo, Japan, simulated mantle convection, together with magmatic activity and movements of the surface lithosphere, over Earth's lifetime. During the first one to two billion years of the simulation, the deep mantle is strongly heated by the core and radioactive decay of elements. Hot material ascends from the lower mantle in large bursts that generate surface magmatism and cause the lithosphere to move chaotically. The vigorous bursts and chaotic movements help to mix the mantle. With time, the rate of heat production wanes, reducing the number of mantle bursts. During this second stage of mantle evolution, rigid tectonic plates form at Earth's surface. The plates migrate in steady motions and slabs of lithosphere subduct into the mantle, taking surface water with them, accumulating in stable piles at the core–mantle boundary. Plumes generated from the top of the piles help return material to the upper mantle.

These second-stage processes occur over about one billion years, however, resulting in a mantle that becomes increasingly poorly mixed. *AW*

BIOGEOCHEMISTRY

Lake carbon

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Excess nutrient levels in many lowland lakes in Europe and North America have led to declines in water quality and, in some cases, fish stocks. However, an analysis of European lake sediments suggests there may be one positive consequence of lake eutrophication: an increase in carbon burial.

John Anderson, of Loughborough University, UK, and colleagues examined the relationship between lake phosphorus levels and organic carbon burial using sediment core data collected from more than 90 European lowland lakes. On average, lake carbon burial increased from around 17 g carbon m^{-2} yr^{-1} in the nineteenth century to around 40 g m^{-2} yr^{-1} in the first half of the twentieth century, and around 60 g m^{-2} yr^{-1} in the latter half. The carbon burial rate reached in the second half of the twentieth century was four to five times greater than the global average. This rise in lake carbon burial was associated with an increase in lake phosphorus levels and rising fertilizer use in Europe. The researchers argue that the positive correlation between lake carbon burial and phosphorus levels points to eutrophication as a principal driver of the increased burial.

If these burial rates apply to other lakes throughout the continent, European lakes may be sequestering three times more carbon than previously thought, the researchers suggest. *AA*

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