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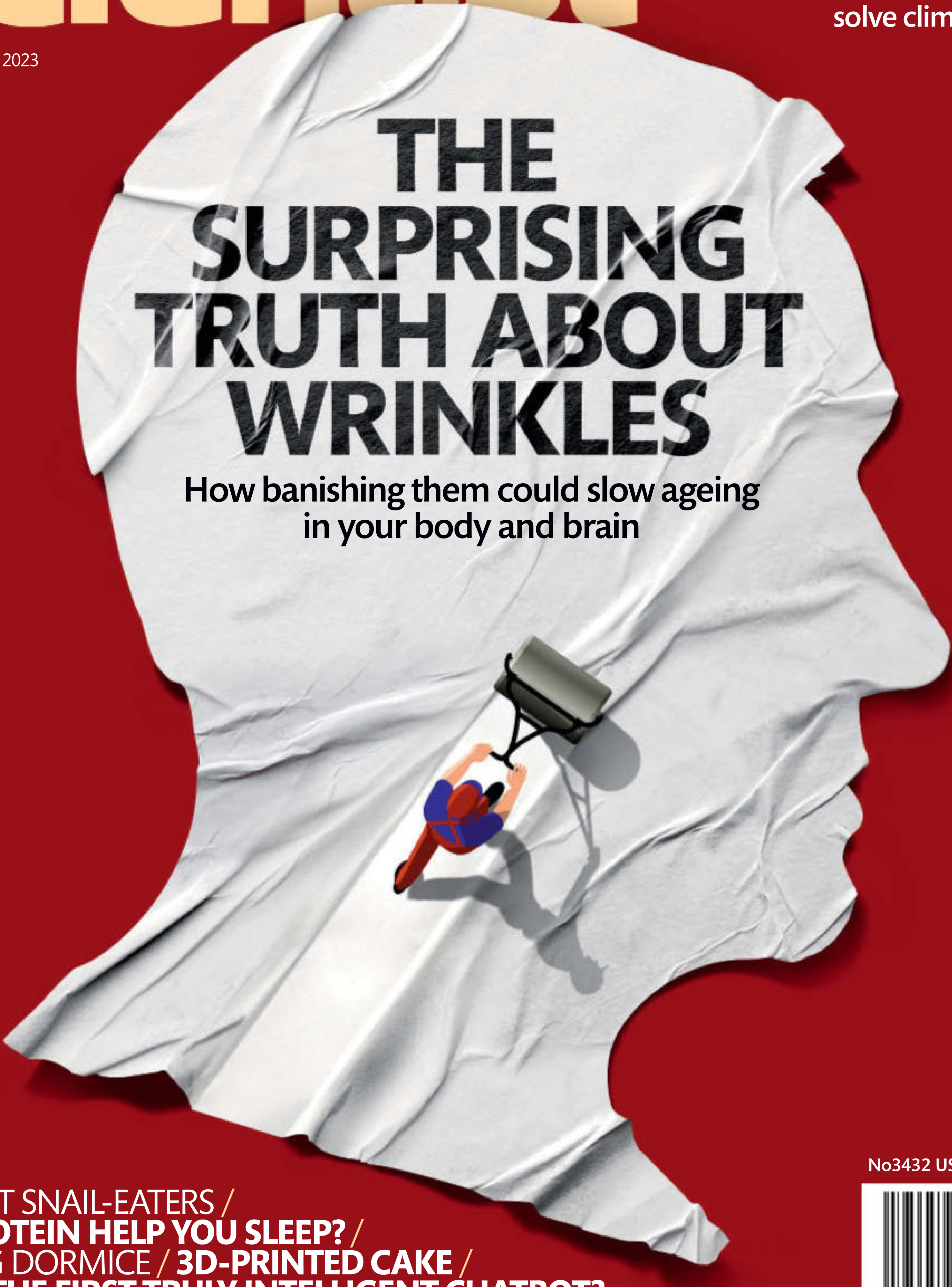

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Solar system

Fissures on icy ocean moons may be too rare to provide conditions for life

Leah Crane

THE seafloors of Europa and Enceladus may not be prone to fracturing. Such fissures are thought to be important for the prospect of life beneath these moons' icy shells, so if there isn't enough stress to cause them, there may also be a shortage of energy and chemicals that potential living organisms would need.

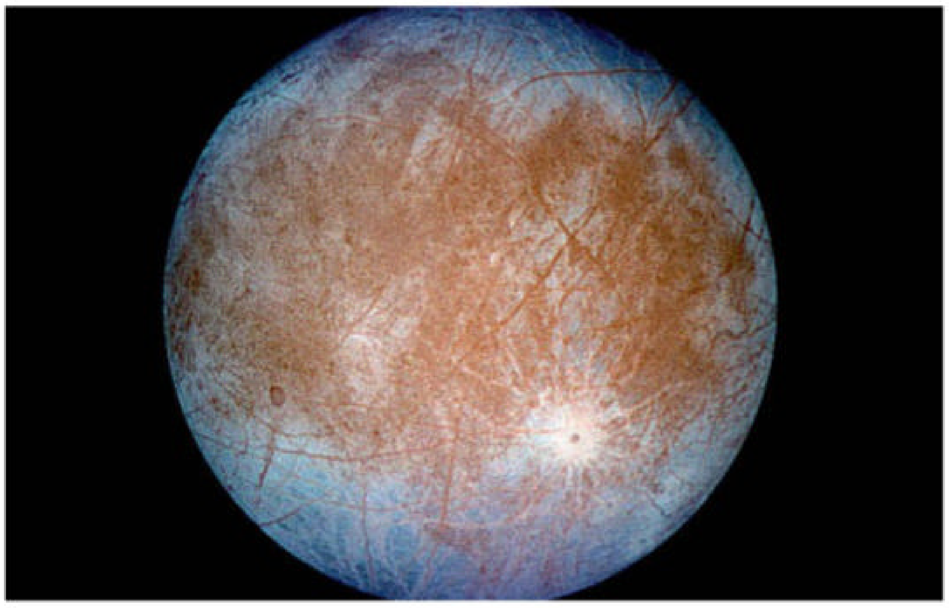
We can't observe the cores of these frigid worlds directly, so we know very little about them. If they fracture often, the fresh rocks revealed could react with the waters overlying them to provide energy and nutrients for potential life in those oceans.

Henry Dawson at Washington University in St. Louis, Missouri, and his colleagues modelled some of the stresses on the icy moons' rocky cores to see if those stresses could crack the rock.

The researchers focused on three main sources of stress to the rock of the seafloors. The first was tidal stress, which occurs because the gravity of the planet – Jupiter for Europa and Saturn for Enceladus – pulls on one side of the moon more intensely than the other, stretching it slightly.

We know from surface features on Enceladus and Europa that this effect is strong enough to crack ice, but the researchers found that it was far from powerful enough to crack the moons' rocky cores. "Even with the weakest rock we can really find, we are still a factor of three lower than we would require [for tidal stress to cause fracturing]," Dawson told the Lunar and Planetary Science Conference (LPSC) in Houston, Texas, on 17 March.

Europa is a large, icy moon that orbits Jupiter



NASA

The second source of stress the researchers considered was contraction of the moons as they cool. They calculated that the solid interior of Europa would have to contract by more than 1 kilometre in diameter in order to cause fissures, which is so significant that it is unlikely to have occurred at all. Enceladus is much smaller than Europa, so it might have shrunk enough to cause faults, but only if it cooled extremely quickly since its formation.

The final source of stress was pressure on the rock from below due to rising magma. The researchers found that this was a plausible way to cause faulting, but we know so little about how magma forms and moves in these sorts of environments that it is impossible to tell for sure.

The work is preliminary, but it isn't looking good for seafloor fissures. "If there aren't enough stresses to produce regular faulting of the rock, that would lead to a less nutrient-rich ocean," said Dawson. "It would be leaning against the possibility of life."

As members of the audience at LPSC pointed out, this is still a bit pessimistic – there may be other ways to weaken the seafloor and create fracturing that Dawson and his colleagues haven't yet investigated, such as expansion of the cores due to reactions between the rocks and the water. Life in the oceans of Europa and Enceladus may not seem as likely as it did before, but it isn't ruled out yet. ▮

Chemistry

Wrinkly graphene could transform hydrogen fuel cells

TINY ripples on graphene's surface let it split hydrogen 100 times more efficiently than any known chemical catalysts. The discovery could lead to improved hydrogen fuel cells.

A one-atom-thick layer of carbon, graphene is essentially a slice of graphite. The latter is an extremely unreactive substance because of its strong carbon bonds. However, Andre Geim at the University of Manchester, UK, and his colleagues have found that graphene, despite also having strong bonds, can be very chemically reactive. This is because it tends not to be totally flat, instead having small undulations in it called nanoripples. These allow it to split hydrogen as effectively as the best catalysts we have today.

To show this, the team produced graphene with as few defects as possible to rule out the effects coming from some other feature, then stretched a sheet of it across the top of a microscopic container filled with hydrogen molecules.

As the graphene split the hydrogen into individual atoms, they built up inside the container, increasing the pressure, making the graphene bulge. The team measured the size of the bulge to calculate graphene's catalytic power.

Its ability per gram to split hydrogen was at least 100 times that of the most widely used catalysts, such as copper or magnesium oxide. However, if you compare the efficiencies of catalysts to their surface area, copper comes out slightly better than graphene.

> "Catalysts based on pure carbon can potentially change many industrial processes"

Geim's team also compared an almost perfectly flat sheet of graphene with one with nanoripples and only the rippled one split hydrogen (*PNAS*, doi.org/grxcvq).

"Most industrial chemical reactions are driven by catalysis, so if we produce catalysts based on pure carbon… then it potentially can change many industrial processes," says Andrei Khlobystov at the University of Nottingham, UK, such as for hydrogen splitting, a process central to hydrogen fuel cells that can produce clean electricity. ▮

Alex Wilkins