THIS WEEK IN Science

edited by Phil Szuromi

Freeze-Thaw Cycles on Mars

Liquid water is not stable under current martian surface conditions, but the presence of small gullies on the poleward-facing slopes of mid- to high-latitude martian surfaces suggests that erosion by liquid water might have occurred. Costard *et al.* (p. 110) developed a global climate model for Mars when it had a higher obliquity (about 300,000 years ago). Their model shows that more melting of the polar ice caps would have occurred and an increase in the surface pressure and temperature at mid- to high-latitudes in the summer would have allowed liquid water to flow. Similarly shaped gullies have been observed in periglacial debris flows from eastern Greenland. These observations, taken together with the modeling, suggest that the martian gullies formed by a freeze-thaw cycle of water on the surface, rather than through flow of an aquifer system.

Magma Flow at Mid-Ocean Ridges

The isotopic concentrations of uranium, thorium, and lead in dredged basalt samples have been used to trace magma flow to mid-ocean ridge spreading centers. Zou *et al.* (p. 107; see the Perspective by Elliott) measured anomalous $^{230}Th/^{238}U$ ratios in basalt samples taken 20 kilometers away from the axis of the East Pacific Rise that indicate the presence of an off-axis magma reservoir or of anomalous lateral flow of melt from the ridge axis. Either source will require revisions to current models of mid-ocean ridge dynamics.

Uncertain Futures

Estimates of uncertainty in predictions of long-term climate change usually are based in part on the informed but still subjective assessment of "experts," and more objective means of determining uncertainty in such forecasts is desirable. Forest *et al.* (p. 113; see the news story by Kerr) use a two-dimensional statistical-dynamical model to evaluate what joint range of values for three of the most important properties that control climate system behavior—climate sensitivity, the rate of heat uptake by the deep ocean, and the strength of the net aerosol forcing—is consistent with 20th-century records of upper-air temperatures, surface temperatures, and ocean temperatures.

Just Add Water?

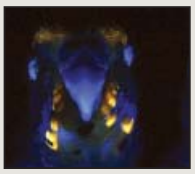
Noble metals resist air oxidation and corrosion by water. Indeed, structural studies of the initial stages of water adsorption on clean surfaces of metals such as ruthenium indicate that simple ice-like bilayers form. Other spectroscopic results appear to be inconsistent with such a structure. Feibelman (p. 99; see the Perspective by Menzel) presents density functional calculations which indicate that water molecules in the first adsorbed layer on the close-packed Ru(0001) surface actually dissociate. The calculated structures show how the oxygen atoms of the first layer can be coplanar and suggest more generally that dissociation may be necessary for water to wet a metal surface.

102 Electrically Excited Single Photons

The development of practical quantum-information processing requires the ability to send single photons on demand. Several techniques have been developed that can provide single photons, but all have been based on systems that have been optically excited. The ideal single photon source would be electrically driven and operate at room temperature. Yuan *et al.* (p. 102) have constructed a device in which a quantum dot is embedded in a p-i-n diode. Although the device operates at temperatures below 200 millikelvin, subnanosecond voltage pulses deliver single photons on demand.

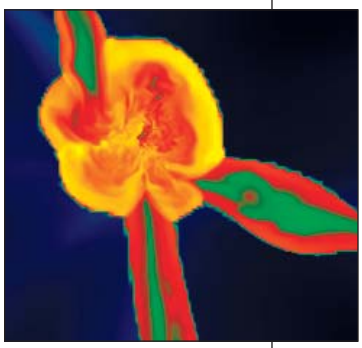
And in Brevia ...

The fluorescent glow of budgerigars' crown and cheek feathers are shown by Arnold *et al.* (p. 92) to be a sexual signal and not merely a by-product of plumage pigmentation.



A Start for Stars

Was the first luminous object in the newly created universe a star or something more exotic? Simulations indicate that large density contrasts in a collapsing protogalactic halo would have fragmented any protostellar core and stifled star formation. Abel *et al.* (p. 93; see the Perspective by Rees and the special issue on star formation) have completed a three-dimensional hydrodynamic simulation of halo collapse from cosmological to stellar length scales, starting with a flat, cold dark matter cosmology. Three-body hydrogen formation could have proceeded without fragmentation long enough and fast enough to allow the development of a stable, fully molecular core. The molecular core then could stably accrete more mass to form a star. Thus, the first light may have been from a star. These simulations also show that metal-free stars can form in isolation from collapsing molecular clouds.



Live Long and Avoid Oxygen Radicals

Severely restricting the food intake of a rat or mouse will result in an extremely long-lived animal. Larsen *et al.* (p. 120; see the Perspective by Tatar and Rand) show that when fed a diet without coenzyme Q, the nematode *Caenorhabditis elegans* can also live a longer life. Coenzyme Q is a lipid electron acceptor necessary for proper function of the respiratory chain in mitochondria. There is a paradoxical similarity in these two cases—why does the lack of proper energy production lead to longer life-spans? The authors propose that less coenzyme Q in nematodes and less food in rodents may result in fewer damaging reactive oxygen species, which are released as a by-product of respiration. Alternatively, the imbalance of coenzyme Q may alter transcription of genes that influence the aging process.

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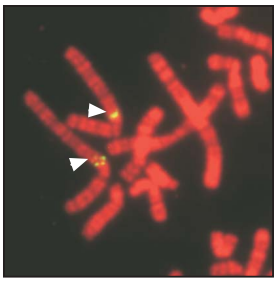
CREDITS: (TOP TO BOTTOM) ARNOLD *ET AL.*; ABEL *ET AL.*

Mineralization by Bacteria

Shewanella putrefaciens has a hitherto unrecognized capacity to generate iron oxide crystals, apparently within membrane-bounded compartments at the poles of the cells. Glasauer *et al.* (p. 117) show that when grown with hydrous ferric oxide, in conditions mimicking natural conditions in the soil, *Shewanella* co-precipitates a variety of fine-grained iron minerals within its cells. Iron may be recycled in these bacteria, and these distinct crystals could provide a useful fossil tracer of prokaryotic life.



Clues from Close and Distant Relatives

The DNA damage response (DDR) process in eukaryotes includes DNA damage–induced checkpoint control pathways and DNA repair processes. Boulton *et al.* (p. 127) describe a combination of protein-protein interaction mapping and high-throughput RNA-mediated interference to identify 23 genes in the *Caenorhabditis elegans* that are required for DDR, 11 of which had not been implicated previously. One of the genes identified is the ortholog of human *BCL3*, a gene frequently altered in chronic lymphocytic leukemia. A first-generation physical map of the chimpanzee genome has been generated that will provide a solid basis and resources for analysis of its genome. Fujiyama *et al.* (p. 131) have mapped more than 60,000 bacterial artificial chromosomes (BACs) from a chimpanzee genome library to the human genome by means of BAC-end sequences to search for relatively large rearrangements between both genomes. Two clusters containing large, nonrandom differences were found relative to human chromosome 21.

Go Fourth and Recombine

It has been reported for many years that unlike the other *Drosophila* chromosomes, the fourth chromosome undergoes no recombination. Wang *et al.* (p. 134) conducted a whole chromosome polymorphism survey of natural *Drosophila* populations from around the world and found an unexpected high level of variation and recombination. This chromosome can be divided into different regions of variation, which suggests that different regions in the fourth chromosome have different evolutionary histories.

Uncapping Tumstatin's Effects

Tumstatin belongs to a family of extracellular matrix-derived protein fragments that have attracted attention as potential anticancer agents because they are potent and nontoxic inhibitors of angiogenesis. Maeshima *et al.* (p. 140) found that tumstatin functions as an endothelial cell-specific inhibitor of protein synthesis that depends on the messenger RNA 5′ cap structure. This activity requires interaction of tumstatin with αVβ3 integrin and results in endothelial cell apoptosis.

Push Me, Pull You

When *Bacillus subtilis* sporulates, its cells undergo an uneven division process during which the chromosomal DNA needs to be transported across a septum from a mother cell into a neighboring daughter cell. Sharp and Pogliano (p. 137) show that the SpoIIIE protein, known to help mediate this process, defines directionality by its preferential localization in the mother cell, from which it actively pumps chromosomal DNA into the forespore. When SpoIIE was forced to accumulate in the forespore, the direction of DNA transport could be reversed.

Molecular Basis of Mossy Fiber LTP

Long-term potentiation (LTP) at hippocampal mossy fiber synapses is distinct from most other forms of LTP. Mellor *et al.* (p. 143) found that the hyperpolarization-activated mixed cation current I_h unexpectedly plays an important role. Calcium entry into the hippocampal granule cells during repetitive stimulation activates a calcium/calmodulin sensitive adenylate cyclase. The subsequent rise in cyclic adenosine monophosphate activates protein kinase A, which leads to increases in I_h. The resulting depolarization causes an enhancement of mossy fiber synaptic transmission.

CREDIT: FUJIYAMA *ET AL.*