Under the ice

Glob. Biogeochem. Cycles
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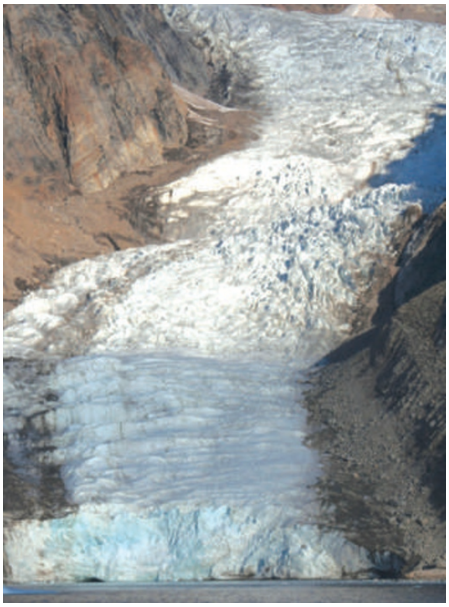

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Chemical analyses indicate that microbial activity beneath the Earth's glaciers could contribute to considerable amounts of chemical weathering beneath the ice.

Jemma Wadham, of the Bristol Glaciology Centre, and colleagues examined the extent and cause of subglacial weathering, using measurements of solutes such as sulphate and bicarbonate from eight major ice masses in the Northern Hemisphere. Based on the relative abundance of compounds released by chemical weathering, the researchers suggest that microbially generated carbon dioxide drives chemical weathering in these environments, and is responsible for the dissolution of both calcite and silicate minerals. In a separate process, the microbial oxidation of sulphide seems to contribute to carbonate and silicate dissolution.

Based on their calculations, the authors suggest that solute fluxes from the Antarctic ice sheet are comparable to fluxes from the world's largest rivers.

Not so simple seamounts

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The formation of seamounts can often be attributed to the passage of oceanic plates across mantle hotspots or magma supplied by nearby plate subduction. However, the geochemistry of seamounts located off the coast of Southern California suggests a more prolonged and complex origin, related to a change in the relative motion of the local plate boundary.

David Clague, at the Monterey Bay Aquarium Research Institute, USA, and colleagues found that the age and chemistry of rock samples collected from the Californian seamounts were similar to the nearby Davidson seamount, but different from the underlying oceanic crust. These data indicate that the emplacement of the seamounts occurred well after the oceanic crust was formed, when the plate margin of California was dominated by subduction.

The researchers propose that the crustal stresses resulting from the transition of the Californian margin from subduction to transform motion created zones of weakness in the oceanic crust. Pockets of melt in the mantle could then have escaped to the surface through these weak areas, forming the enigmatic seamounts.

Wet martian mantle?

Earth Planet. Sci. Lett. **292,** 132–138 (2010)

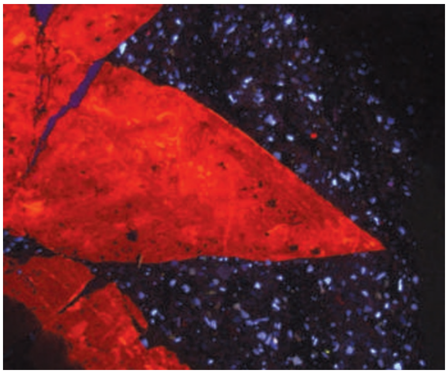
Abundant water is thought to have flowed on the surface of Mars in the past, and it has generally been suggested that the water was delivered by icy comets and meteorites. An analysis of meteorites that came from Mars now indicates that the water may have risen from the planet's interior.

Francis McCubbin, of the Carnegie Institution of Washington, and colleagues found that meteorites from Mars have surprisingly high amounts of water locked up in hydrous minerals. The presence of water-rich minerals implies that the interior of the planet may have been much wetter than previously thought.

On Earth, volcanic activity can release water vapour to the atmosphere as a volcanic gas. The researchers suggest similar processes could have brought water to the surface of Mars during the planet's early years. Such hydrothermal systems could have provided a continuous source of water long after the rain of icy comets dwindled and the martian climate cooled.

Greenhouse glacials

Geology **38,** 251–254 (2010)



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The greenhouse warmth of the Cretaceous period was punctuated by a transient shift to glacial conditions about 137 million years ago, according to a temperature reconstruction from the Arctic Ocean.

Gregory Price of the University of Plymouth and Elizabeth Nunn of Johannes Gutenberg-Univeritӓt Mainz used co-existing fossils and carbonate minerals preserved in marine rocks from Svalbard to reconstruct temperatures from about 140 to 136 million years ago. Conditions at Svalbard — which was then a shallow sea located near the Arctic Circle — were generally warm, averaging about 13 °C. However, the authors found a brief descent into a more glacial-like climate about 137 million years ago, with ocean temperatures between 4 and 8 °C.

Purported corroborating evidence for Cretaceous cold spells from other sources remains controversial, but simulations with general circulation models indicate cooler conditions at the poles than suggested by previous proxy-based temperature reconstructions.

Earth's early shield

Science **327,** 1238–1240 (2010)

It has been difficult to determine when the Earth's magnetic field, which shields the planet from the solar wind, became active. Now ancient volcanic rocks reveal the presence of a magnetic field on Earth 3.4 billion years ago.

John Tarduno, of the University of Rochester, New York, and colleagues reconstructed the magnetic properties of rocks that were erupted onto the Earth's surface between 3.45 and 3.4 billion years ago. Crystals of quartz from these rocks carry the signature of an active magnetic field, with a strength of about 50 to 70% that of the present-day field. However, the researchers point out that the early Sun, though fainter, was probably far more active than today, producing a much stronger solar wind.

Thus, although the weak magnetic field should have prevented the large-scale erosion of the atmosphere by the wind, the Earth still probably lost a great deal of hydrogen, water and other volatiles before the Sun calmed and the magnetic field reached its full strength.