

## Paleocene Warming at Depth

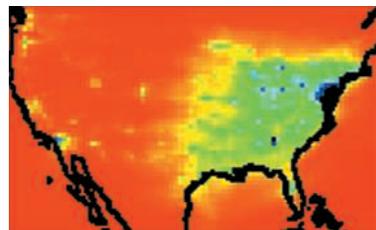
The Paleocene-Eocene Thermal Maximum (PETM) was a geologically brief period of warming that occurred about 55 million years ago. During this episode, the global carbon cycle was significantly perturbed, as reflected by a large and sudden change in the carbon isotopic composition of the global active carbon pool. This perturbation may have been caused by a massive release of methane hydrates from the sea floor, but the cause of such a release is not understood. **Tripati and Elderfield** (p. 1894) present benthic ocean temperature records from intermediate-depth waters in both hemispheres and near the equator which show that all of those locations warmed roughly equally, by 4° to 5°C, slightly ahead of the corresponding changes in the carbon system. These data are consistent with the idea that destabilization of methane clathrates in marine sediments were involved as a source of the isotopically anomalous carbon during the event.

## Thicker in the Middle

The mass balance of Antarctica's ice sheets is a critical parameter in any evaluation of the potential sea level rise that would accompany global warming. **Davis et al.** (p. 1898, published online 19 May 2005; see the Perspective by **Vaughan**) report results, derived from measurements made by satellite radar altimetry conducted from 1992 to 2003, which show that large parts of the interior of Antarctica gained mass during that time. They attribute this increase to a rise in precipitation in East Antarctica, an effect that has been suggested to accompany global warming. The mass balance of the entire ice sheet is still uncertain, however, because mass loss in areas near the coast that are not accessible to this technique could be even greater than the gains seen in the interior.

## Assessing a Hydrogen Future

The pollution reductions and health gains that would follow from powering cars and trucks with hydrogen are well understood in principle, but a detailed analysis of those benefits would be useful. **Jacobson et al.** (p. 1901) present such a model study of the effects of converting the entire United States vehicle fleet to hydrogen fuel cells or fossil fuel-electric hybrid vehicles. The use of hydrogen fuel cell vehicles reduces pollution and adverse health



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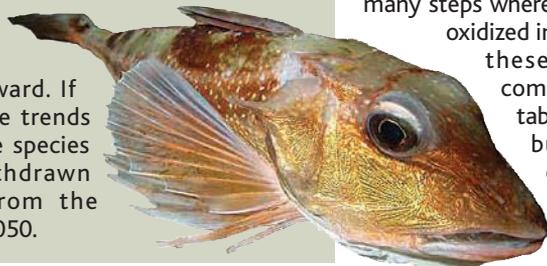
effects in all cases, but to what extent depends on how the hydrogen is produced. In the best case, the generation of hydrogen by wind power may make it a more economical fuel than gasoline when all costs are considered.

## Weighing Earth's Core

Seismic velocities and comparisons with experiments have been used to infer the density of Earth's interior, often through a linear extrapolation known as Birch's Law. This analysis has indicated that Earth's inner core is mostly an iron-nickel alloy that must contain some light elements, such as sulfur or oxygen. However, this inference requires knowledge of how seismic velocities vary, not just with density but also temperature. **Lin et al.** (p. 1892) directly measured seismic velocities in iron at high pressure and at several temperatures. Temperatures comparable to those in the deep Earth reduce the sound velocity relative to the inferred density. Thus, Earth's core requires more light elements than indicated from a linear relation with density, a finding more consistent with other inferences.

## A Changing Climate for Fish and Chips

Climate change is well established as a potential threat to biodiversity and the services and benefits that people gain from ecosystems. **Perry et al.** (p. 1912, published online 12 May 2005) examined the effects of climate change on a key ecosystem service, marine fisheries. Many species have exhibited a strong northward shift during the last 25 years in the North Sea. Many commercially important fish such as cod, whiting, and anglerfish have shifted from 50 to 800 kilometers northward. If current climate trends continue, some species may have withdrawn completely from the North Sea by 2050.



## Burning Up

Understanding fire is one of the oldest challenges in chemistry. Spectroscopy studies of flames can identify molecular fragments, which then serve as input for kinetic models that sort out the many steps whereby hydrocarbons are oxidized into water and CO<sub>2</sub>. In these models, carbonyl compounds are well-established intermediates, but their less stable enol tautomers, which bear an OH group bound to a C=C double bond, are not. **Taatjes et al.**

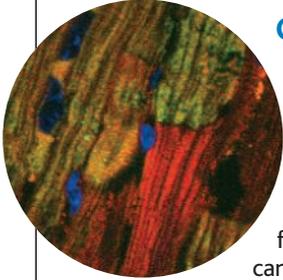
(p. 1887, published online 12 May 2005; see the cover) have now observed significant amounts of two-, three-, and four-carbon enols in flames burning commercial gasoline constituents. A clean, low-temperature hydrocarbon oxidation is achieved by tyrosinase enzymes, in which two copper ions in the active site bind O<sub>2</sub> and catalyze the formal insertion of an O atom into an aromatic C-H bond in phenol. Synthetic chemists have assumed that the hydrocarbon interacts with the bound O<sub>2</sub> before it cleaves. **Mirica et al.** (p. 1890; see the Perspective by **Reedijk**) present evidence from a model complex that suggests a different pathway. Spectroscopic studies of a compound in which a copper dimer mimicks the O<sub>2</sub> binding site of the enzyme reveal a reactive intermediate at -120°C in which the O<sub>2</sub> bond is broken before oxygen transfer to a phenol derivative. These results suggest that the enzymatic oxidation could likewise involve phenol attack on an electrophilic copper (III) bridging oxo species.

## Absent Allies

A major difficulty in developing a vaccine against human immunodeficiency virus (HIV) is the high level of escape by the virus when it encounters antibodies within each host. Nevertheless, a small handful of monoclonal antibodies broadly specific for HIV can neutralize the virus, and they have been studied carefully

CONTINUED ON PAGE 1839

with the hope of understanding why similar antibodies are not generated easily during a normal immune response. **Haynes *et al.*** (p. 1906, published online 28 April 2005; see the Perspective by **Nabel**) find that two of the monoclonal antibodies possess a range of specificities and react against the human phospholipid, cardiolipin. Thus, broadly neutralizing antibodies may be seen so rarely in HIV infection because the very features that endow anti-HIV properties also make them self-reactive and, as such, they are not tolerated by the body's immune system.



### Catalase for Longer Life

Cell and tissue damage caused by free radical oxygen molecules have been linked to aging pathologies, yet the idea that antioxidant defenses can prolong life has been controversial. **Schriner *et al.*** (p. 1909, published online 5 May 2005; see the Perspective by **Miller**) generated transgenic mice that overexpress catalase in mitochondria, a major source within the cell of oxygen free radicals. Catalase removes damaging hydrogen peroxide that can generate reactive oxygen species. In the transgenic mice, cellular oxidative damage and age-related decline in heart function were reduced and cataract formation was delayed. In addition, life span increased by nearly 20%. Thus, antioxidant enzymes can promote mammalian longevity.

### Calling New Neurons

Most neurogenesis in the brain occurs in the context of early development. However, even through adulthood, a steady stream of newly generated neurons supplies the olfactory bulb. Neuronal progenitors from the subventricular zone of the brain migrate together as a chain to the olfactory bulb. **Ng *et al.*** (p. 1923) have now identified prokineticin 2 (PK2) as one of the signals that calls the neurons to their destination. Prokineticin proteins are secreted, and in other locations also regulate processes such as gastrointestinal motility and pain sensitization. The mammalian retina, like other regions of the brain, develops in a sequential manner. Cells of a given function are born earlier, whereas those born later are dedicated to other functions. **Kim *et al.*** (p. 1927) have clarified how one signaling molecule, growth and differentiation factor 11 (GDF11), affects this trajectory of differentiation in the retina differently than in the olfactory epithelium. In the developing retina, GDF11 does not affect proliferation of progenitor cells, as it does in the olfactory epithelium, but signals to the progenitor cells competence to produce certain types of differentiated cells.

### Alarming the Mob

Although there has been much interest in the function and evolution of alarm signals in animals, few studies have been able to control the presentation of predators to prey species and elucidate any complexity of meaning that might be encoded in these signals. **Templeton *et al.*** (p. 1934; see the news story by **Miller**) exposed black-capped chickadees, a common North American songbird, to various different species and sizes of predator. Chickadees living in small flocks responded to alarm calls by mobbing the threatening predator. Spectrographic analyses showed striking differences in chickadee alarm calls that correlating strongly with the size and threat of the potential predators. Furthermore, the chickadees responded to recordings of the different alarm calls by varying their mobbing behavior.

### Agrin Yes, Neuregulin No

Neuromuscular junctions develop through a series of reciprocal interactions between the muscle fiber and the incoming motor neuron. Both agrin and neuregulin have been implicated in neuromuscular junction development. **Escher *et al.*** (p. 1920) use targeted gene ablations to clarify which molecules act when. It seems that neuregulins are not critical for neuromuscular junction formation, but agrin is. The previously observed effects of neuregulin signaling disruptions on neuromuscular junction formation may well have been mediated indirectly through the effects of neuregulins on Schwann cells, which surround the neuromuscular junction.