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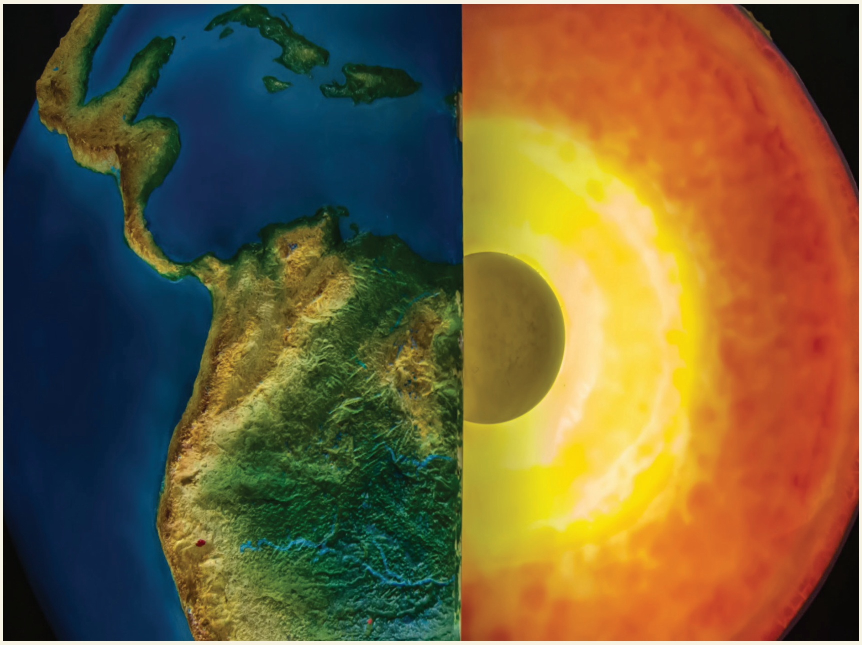
Carbon content of Earth's core

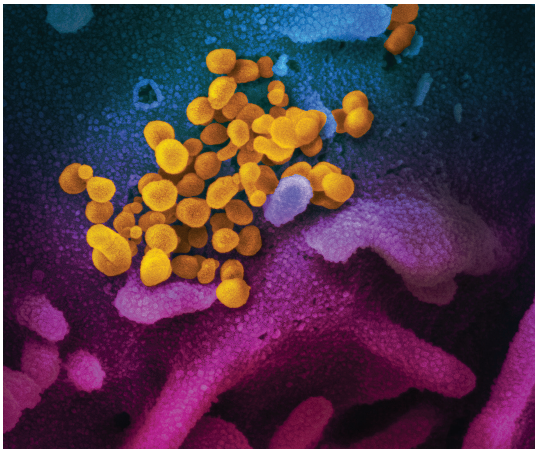
The total amount of carbon on Earth—the bulk carbon content—is poorly understood due to uncertainty in the amount of carbon in Earth's core, where most carbon is likely located. To better estimate the carbon content of Earth's core, Rebecca Fischer et al. (pp. 8743–8749) measured the preference of carbon for mixing with iron and nickel, which represents the composition of the core, over a silicate mineral, such as those found in Earth's mantle. The authors performed the measurements at pressures of 37–59 GPa and temperatures of 4200–5200 K, approximating the conditions under which Earth's core formed. Under these conditions, the preference of carbon for iron and nickel was two orders of magnitude lower than that measured in previous studies at more modest temperatures and pressures. Combining the results with previously published values of the carbon content of the mantle, the authors estimated that carbon constitutes a miniscule fraction of Earth's core: 66–220 ppm, assuming the core formed in a single stage, or 0.09–0.20 wt% based on a model of multistage core formation. However, this small fraction of the core nevertheless represents approximately 80–90% of Earth's bulk carbon content, according to the authors. — B.D.



Cutaway of Earth showing the core. Image credit: PublicDomainPictures.net/alex grichenko.

Critical care demand for COVID-19 outbreak

Community transmission of coronavirus disease 2019 (COVID-19) in the United States is expected to dramatically increase demand for critical care facilities. Using a model of COVID-19 transmission that incorporates US population demographics, Seyed Moghadas, Affan Shoukat, et al. (pp. 9122–9126) projected future COVID-19–associated demand for intensive care unit (ICU) beds in the United States. Assuming a basic reproduction number R_0 of 2.5, the authors projected that in the absence of self-isolation, treating all critically ill cases at the height of the outbreak would require nearly 300,000 ICU beds, or three times the number of existing ICU beds in the country. For a lower R_0 of 2, approximately 150,000 ICU beds would be



Scanning electron microscope image of severe acute respiratory syndrome coronavirus 2 (yellow). Image credit: Flickr/NIAID.

required in the absence of self-isolation—1.5 times the existing number of ICU beds. Self-isolation of 20% of cases within 24 hours of symptom onset would reduce peak weekly demand for ICU beds by nearly 50% for an R_0 of 2.5 and by nearly 75% for an R_0 of 2, although demand would still exceed existing capacity in the former scenario. The results suggest that COVID-19 will likely overwhelm the country's existing critical care capacity and that policies to expand ICU capacity and encourage self-isolation are urgently needed, according to the authors. — B.D.

Fossil evidence of arthropod ancestor

The evolutionary history of arthropods, including insects and arachnids, is thought to originate in an aquatic environment based on marine fossils from the Cambrian Period and molecular dating. However, fossils of land-dwelling arthropod ancestors in aquatic environments have not been found. Gregory Edgecombe et al. (pp. 8966–8972) examined fossils from Scotland of a group called the euthycarcinoids, a putative relative of the Myriapoda, an arthropod group that includes centipedes and millipedes. Details of the head structure of the euthycarcinoid, which dates to the Devonian Period, are similar to those in living myriapods, suggesting that myriapods may be the closest relatives to euthycarcinoids. Euthycarcinoids extend back to the Cambrian Period, providing an early aquatic ancestor to land-living modern arthropods. Fossilized tracks and other traces of euthycarcinoids, including tracks on tidal flats, suggesting a transition from marine to terrestrial environments, where most current diversity in arthropods is found. According to the authors, the results help reconcile the molecular and fossil evolutionary records for myriapods and provide a window into the process by which this group transitioned from the sea to the land. — P.G.

Section through mouthparts of euthycarcinoid *Heterocrania rhyniensis* from the Devonian Period in Scotland. Field of view is around 3-mm wide in the actual fossil.

Genetic code expansion in human stem cells

Noncanonical amino acids (ncAAs) can be genetically incorporated into proteins for studying and manipulating protein structure and function. Several ncAAs have been successfully incorporated into bacteria, yeast, mammalian cells, and other multicellular organisms, but not human systems. Sida Shao et al. (pp. 8845–8849) incorporated ncAAs into human hematopoietic stem cells (HSCs), which are precursors of blood cells, using a vector derived from Epstein-Barr virus that is capable of self-replication. The viral vector encoded a transfer RNA (tRNA) capable of incorporating a variety of lysine-derived ncAAs into proteins at the amber stop codon, along with the corresponding aminoacyl tRNA synthetase enzyme. The authors introduced this vector into human HSCs isolated from umbilical cord blood and found that both the initial HSCs and their differentiated progeny incorporated ncAAs into proteins encoded by the vector. The modified HSCs could be engrafted into mice, resulting in the production of ncAA-containing proteins when the mice were supplied with dietary ncAAs. The results suggest that other human stem cell types could be similarly modified to use ncAAs, providing tools to study human proteins in cell culture and living organisms, according to the authors. — B.D.

Reducing carbon emissions with carbon markets

International carbon markets put a price on carbon use in an effort to curb pollution from carbon emissions. However, whether these markets remain effective when carbon prices are low remains a subject of debate. Patrick Bayer and Michaël Aklin (pp. 8804–8812) examined whether the European Union Trading System (EU ETS) reduced carbon emissions despite low carbon prices. For the analyses, the authors created a statistical model that combined two sets of sectoral emissions data spanning 1990–2016. The authors found that the EU ETS prevented approximately 1.2 billion tons of carbon dioxide from being emitted between 2008 and 2016. Accounting for the financial crisis that occurred between 2007 and 2008, an estimated 8.1–11.5% of emission reductions in regulated sectors was still attributable to the EU ETS. The authors also determined that low prices may have been indicative of a decrease in demand for emission permits, and that the EU ETS incentivized changes in emission patterns throughout Europe. The findings suggest that EU carbon markets are effective despite low carbon prices and that their effectiveness increases over time, according to the authors. — M.S.

Carbon markets are effective despite low carbon prices. Image credit: Pixabay/digifly840.