The linearity of the relationship between cloud cover and aerosol forcing makes it possible to define a critical cloud fraction at which aerosols switch from exerting a net cooling to a net warming effect. The average cloud cover in the southeastern Atlantic Ocean between July and October exceeded this critical threshold, suggesting that the net effect of aerosols in this region, at least at this time, will be to warm the atmosphere. Indeed, using their cloud and aerosol retrieval data, they calculated that aerosols will exert a positive radiative forcing of roughly 2.4 Wm^{-2}. However, when they ran the calculations assuming that the spatial pattern of aerosols was independent of the clouds, regional warming was reduced threefold, to 0.8 Wm^{-2}. The data indicate that spatial co-variation between lofted aerosols and low-level cloud cover is a critical control on aerosol forcing.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[8] estimates that the direct radiative forcing associated with aerosols is -0.5 ± 0.4 Wm^{2}. That is, globally aerosols are expected to cool the planet. This aerosol induced cooling is roughly 20% of the magnitude of present-day greenhouse-gas-induced warming, providing a significant counterbalance to a mostly positive forcing. However, the results of Chand *et al.* indicate that aerosols may in fact warm the tropical Atlantic Ocean, despite the negative global mean. This suggests that IPCC global estimates are unable to account for the complexity of aerosol forcing, which will vary regionally, seasonally and with cloud cover[10].

The work of Chand *et al.*[5] would not have been possible without the CALIPSO lidar and the MODIS imager, demonstrating the need for continued and comprehensive measurements of aerosol and cloud properties using both passive and active satellite sensors, supplemented by focused suborbital campaigns and long-term surface stations. Without these measurements, determining the climatic influence of particulate matter in the atmosphere, in a shifting hydrologic regime, will not be possible. ❐

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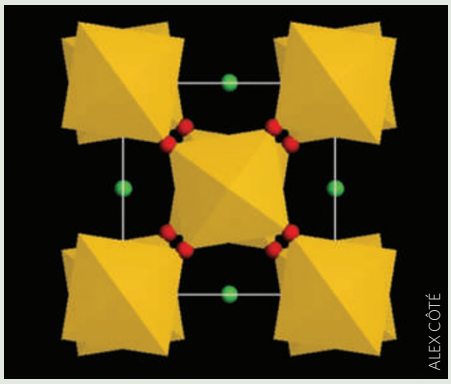
MANTLE MINERALOGY

Deep heat

When compared with the Earth's compositionally diverse crust, the planet's lower mantle might seem a dull place: it is dominated by only a few main elements, namely oxygen, silicon, magnesium and subsidiary iron. Yet, this deep and unseen part of the Earth is also thought to contain minor amounts of other elements, such as calcium, aluminium and even uranium. In fact, previous work indicates that almost half of Earth's inventory of uranium may lie in the lower mantle. This element can generate substantial amounts of heat by radioactive decay.

Exactly where uranium sits in the lower mantle is not clear. One possibility suggested by laboratory work is that this element is incorporated in the crystal structure of a relatively common lower-mantle mineral known as aluminous calcium perovskite, by replacing some of the calcium atoms that have a similar atomic size. To further clarify how uranium enters the structure of this mineral, Steeve Gréaux and colleagues conducted additional laboratory experiments (*Phys. Earth Planet. Inter.* doi:10.1016/j.pepi.2008.06.010; 2009).

They synthesized aluminium-bearing calcium perovskite and mixed it with natural uranium oxide under



the conditions thought to occur in the deep Earth: crushing pressures scarcely imaginable and temperatures of 1,700 °C or more that can easily melt iron. The results show that as the perovskite crystals grow, uranium finds its way into the crystal structure by diffusion. Although pressure is known to reduce the efficiency of diffusion, the researchers found that the positive effect of temperature on this process far outweighed any adverse effects of the high pressure.

Interestingly, aluminium seems to have an important role in the diffusion of uranium into calcium perovskite — in experiments with an aluminium-free form, the mineral did not allow uranium into its crystal structure. Apparently, when aluminium replaces the silicon that is otherwise incorporated in the perovskite, the crystal structure is altered subtly in such a way that uranium can squeeze in too. Furthermore, the incorporation of uranium, in addition to the presence of aluminium, has a marked effect on the compressibility of calcium perovskite and could affect the physical properties of the lower mantle.

Pressures in the deepest parts of the mantle are thought to be even higher than those in the experiment. However, the researchers argue that additional pressure should not have a marked effect on the structure of the perovskite. In light of its abundance and capacity to accommodate uranium in its structure, this mineral may be the most important repository of uranium in the deep Earth. Moreover, if there are regions in the lower mantle with higher than average concentrations of the mineral, the decaying uranium could provide enough heat to generate the buoyant upwellings that have been detected by seismic techniques.

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