NANOTECHNOLOGY

Downsizing SQUIDS

They sound fishy, but SQUIDs — superconducting quantum interference devices — are ultra-sensitive gadgets used for measuring the strength of magnetic fields. These 'magnetometers' have widespread applications ranging from materials science to medicine. Writing in *Nature Nanotechnology*, Cleuziou, Wernsdorfer and colleagues describe a minuscule version of this useful device (J.-P. Cleuziou *et al.* *Nature Nanotech.* **1**, 53–59; 2006).

The 'nano-SQUID' is made of a square loop of 50-nm-thick aluminium wire, which becomes

superconducting at temperatures below 1.2 K. Insulating junctions disrupt the loop in two places, with each junction consisting of a single-walled carbon nanotube. The maximum supercurrent flowing through the loop varies with changes in the magnetic flux (the magnetic field multiplied by the area) passing through the loop. This response is what makes SQUIDs such sensitive magnetometers.

The nanotube junctions behave like 'quantum dots', which have discrete electronic energy levels. The alignment of these energy levels with those of the superconducting

wire can be controlled by applying a voltage near to either — or both — of the nanotube junctions. In this way, the voltage effectively turns the current on (energy levels aligned) and off (misaligned). The two-dimensional colour plot shown on the right indicates the peaks (red) and valleys (blue) in the conductance of the device as the junctions are tuned through their on and off states.

So why make a SQUID that has carbon-nanotube junctions? The ultimate goal is to detect changes in direction of the magnetic moment of a single molecule or nanoparticle. This could be achieved by placing the nanoparticle directly on one of the nanotubes, optimizing the magnetic

flux passing through the loop and so maximizing the device's sensitivity. Although such a measurement has not yet been made, it is well within the sensitivity of this tiniest of SQUIDs.

Jessica Thomas

heavier lithium than has normal depleted mantle. This is surprising, as they would have been expected to be isotopically lighter if the enriched mantle were formed by simple mixing of subducted oceanic crust whose ^7Li had largely escaped upwards into the mantle wedge during dewatering.

So where did this heavy lithium come from? Elliott *et al.*¹ propose that, in fact, it is the same heavy lithium that is released during dewatering of a subducting slab. In their model, the mantle wedge immediately above a subducting slab is initially relatively cold and viscously coupled to the downgoing slab. As it warms up, it eventually peels away from the denser basaltic slab, and remixes with surrounding depleted mantle to produce enriched domains (Fig. 1). Although the ultimate fate of the slab remains unknown, this model provides a solution for another mystery: the surprising absence of heavy lithium isotope signatures in most arc volcanoes, despite abundant evidence that their mantle source regions contain fluids from the subducting slab⁹. Elliott and colleagues' model supports previous speculation that lithium is rapidly scavenged from slab fluid as it percolates through the mantle wedge, owing to an affinity of lithium for magnesium silicate minerals in the mantle⁹.

Confirmation of this model will require further study of how lithium behaves during dewatering of subducting oceanic lithosphere. Limited work on eclogites — rocks thought to be fragments of previously subducted oceanic crust — show a wide range of lithium isotope signatures, but generally support the notion that isotopically heavy lithium is released during slab dewatering⁸. Although it remains to be shown that subducted oceanic crust is uniformly light in its lithium isotopic signature, Elliott and colleagues' demonstration of lithium isotopic variations in enriched MORBs remains strong evidence for the importance of

crustal recycling — in one form or another — in the evolution of Earth's upper mantle. ■

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MICROBIOLOGY

Resurrecting a broken genome

Susan T. Lovett

A remarkable bacterium can survive extraordinary doses of ionizing radiation that shatter its genome into thousands of pieces. How does it accurately reassemble these DNA fragments into an intact genome?

Aficionados of DNA repair can't help but be impressed by the small but mighty bacterium *Deinococcus radiodurans*. When its genome is smashed into thousands of little pieces by ionizing radiation, *D. radiodurans* can reconstruct it without error¹. This lowly organism, which thrives in nuclear waste², can certainly teach us a thing or two about DNA repair. On page 569 of this issue, Zahradka *et al.*³ reveal how this bacterium manages to rebuild its shattered chromosomes*.

Deinococcus radiodurans was isolated in 1956 as a contaminant in canned meat that had been treated with 4,000 gray of γ -rays⁴, a dose many hundreds of times greater than that required to kill 'normal' bacteria such as *Escherichia coli*. Given that no terrestrial environment

*This article and the paper concerned³ were published online on 27 September 2006.

experiences such enormous doses of radiation, how on Earth has this radiation resistance evolved? The answer is simple: radiation resistance correlates with resistance to desiccation⁵. *Deinococci* are aerobic bacteria found in soil around the globe. Prolonged dehydration, like ionizing radiation, induces potentially lethal double-strand DNA breaks in the bacterial genome. Presumably, *D. radiodurans* has evolved to survive dry periods in its soil environment by developing efficient mechanisms for repairing chromosome breaks. Extremely radiation-resistant bacteria from surprisingly diverse lineages are readily isolated from desert soil^{6,7}, so this trait seems to have arisen many times as a response to arid environments.

In the 50 years following the discovery of extreme radiation resistance in bacteria, many people have pondered over its mechanism