photographs of Greenland's glaciers to document their history. But peering through ice to the bedrock — which can be hundreds or thousands of metres down — requires seismic surveys or, more typically, radar.

In aeroplane radar surveys, researchers fly over the ice, pinging radar signals downwards and measuring how they bounce off the interface between the ice and the bedrock. The data reveal not only the thickness of the ice, but also whether there are signs of melting such as subglacial lakes or ice accumulations where the flowing ice gets caught on a rough spot in the underlying rock.

In Antarctica, the first widespread radar mapping took place between 1967 and 1979, in a programme run jointly by the Scott Polar Research Institute (SPRI) in Cambridge, UK; the US National Science Foundation; and the Technical University of Denmark in Lyngby. Their scientists flew more than 250,000 kilometres across much of West Antarctica — including the areas draining to the Ross and Ronne ice shelves — and part of East Antarctica, including the famous ice-core-drilling sites Vostok and Dome C.

Scientists used the data to explore Antarctic ice thickness and the distribution of subglacial lakes. But the information mostly sat as rolls of 35 mm, 8 mm and Super 8 film in the SPRI library. Very little of it had been digitized until Schroeder began to wonder about it, and SPRI director Julian Dowdeswell invited him to Cambridge.

Using start-up funds for his Stanford laboratory, Schroeder started looking for experts who could handle old film. He called the Academy of Motion Picture Arts and Sciences in Hollywood, which pointed him to companies that restore film. He bought a specialized scanner, hunted down some of the vintage equipment that he needed on eBay, and flew with two art historians to Cambridge in June 2016. Over the course of 2 weeks, they carefully cut, taped and scanned about 1,000 rolls of archival film.

WHAT LIES BENEATH

Schroeder has already spotted fine details in the data, such as channels beneath ice shelves and accretion plumes where ice has been piling up. These features had been observed before, Schroeder says, "but now that we know we can see them, we'll look for new ones, too".

Modern radar mapping of Antarctica didn't begin in earnest until the 1990s, so pushing the data set back another two decades is a significant improvement, he says.

The 1970s data are of such high resolution that they can be used to improve bedrock-topography maps of Antarctica (P. Fretwell *et al. Cryosphere* **7**, 375-393; 2013). These are crucial for modellers as they test how ice sheets respond to changing temperatures.

Schroeder hopes soon to digitize similar 1970s radar data for Greenland. ■

BIOTECHNOLOGY

Gene editing staves off deafness in mice

Technique to knock out mutant gene uses fatty molecules to deliver CRISPR components to inner-ear cells.

BY HEIDI LEDFORD

Genome editing has been used to reduce hearing loss in 'Beethoven' mice, which carry a mutation that causes deafness in both mice and humans.

The research relies on a technique called CRISPR–Cas9 to knock out a mutant form of the gene *Tmc1*. In doing so, it lays out a potential pathway for treating other genetic causes of hearing loss. It also addresses a major problem facing the field of genome editing: how to deliver the protein and RNA needed for the CRISPR–Cas9 technique into the cells of a living animal.

In this case, the researchers encapsulated the CRISPR components in positively charged fatty molecules called lipids, which are capable of crossing cell membranes. They then injected those particles directly into the inner ears of the mice, where the lipids were taken up by the hair cells that sense acoustic vibrations. The results are reported this week in *Nature* (X. Gao *et al. Nature* http://dx.doi.org/10.1038/nature25164; 2017).

The method could be used to enable gene therapy in people, if additional testing shows it to be safe and effective, says David Liu, a chemical biologist at the Broad Institute of MIT and Harvard in Cambridge, Massachusetts, and a lead author of the study.

That could be an important step forward, says bioengineer Charles Gersbach of Duke University in Durham, North Carolina. "The vast majority of papers that you see where they're using CRISPR to correct a mutation in an animal model, they are using delivery systems that aren't applicable to treating diseases in humans," he says. "Delivery is still a challenge."

CRISPR–Cas9 gene editing uses the Cas9 enzyme to cut DNA at a site dictated by the sequence of a snippet of RNA, called a guide RNA. To edit genes in the cells of living animals, researchers often use viruses to shuttle in the DNA that encodes Cas9 and the guide RNA. Once inside the cell, the DNA is expressed and the cell produces both components.

But those viruses have been carefully engineered for classical gene therapy, in which they are used to express a normal copy of a particular gene at high levels and for as long as possible. Researchers who are editing genomes instead prefer that Cas9 is expressed for just enough time to make its targeted

NACHO DOCE/REUTERS

Gene editing could one day prevent deafness in people who have a mutation that causes hearing loss.

change — and that it doesn't hang around long enough to raise the risk of undesired changes.

This was particularly important for the Beethoven mice, because the animals carry one mutated copy and one normal copy of the *Tmc1* gene. The two versions differ by only a single DNA letter, and Liu's team wanted Cas9 to disable the mutated copy — not the normal one. Rather than use a virus, Liu's team injected the lipid-encased Cas9 protein bound to its guide RNA into one ear of each mouse and then tested the hearing in each ear up to eight weeks later.

In all the tests, mice with treated ears performed better than control mice that had not been injected with the gene-editing components. For example, eight weeks after the injection, untreated control mice did not react to an abrupt 120-decibel noise — roughly the volume of a rock concert or a chainsaw. Mice that received the treatment, however, were significantly startled by the noise.

"This is a nice extension of previous work," says Daniel Anderson, a biomedical engineer at the Massachusetts Institute of Technology in Cambridge. The ability to selectively knock out the mutant form of the gene, despite a difference of just one DNA letter between it and the normal form, highlights the potential of CRISPR–Cas9 gene editing, he notes.

It will take further tests in animals and people before it will be clear whether the same approach could work for humans who have *TMC1* mutations. (Liu is co-founder of the company Editas Medicine, also in Cambridge, which aims to develop therapies that harness CRISPR–Cas9 to treat genetic disorders.) Liu's lab is also hoping to test the technique in the eye, to tackle genetic causes of blindness.

The Cas9 protein and its guide RNA are unlikely to travel far from the site of injection, making the approach ill-suited to treating conditions such as muscular dystrophy, which affect large swathes of tissue.

"The delivery method very much needs to be catered to the exact disease and what cells you're delivering to," says Gersbach, who advises Editas. "This work is a step in that direction." ■

TECHNOLOGY

Blockchain moves to science

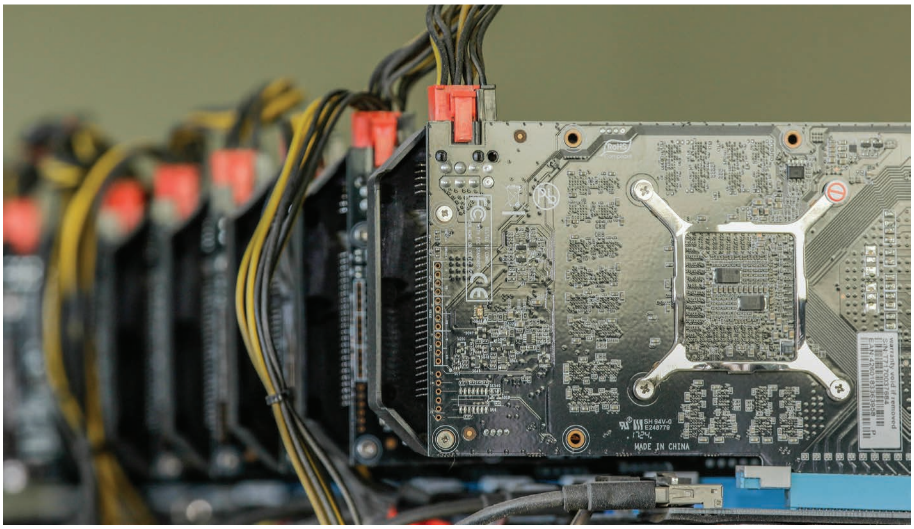
Proponents say the system behind Bitcoin could lend security measures to the scientific process.

BY ANDY EXTANCE

The much-hyped technology behind Bitcoin, known as blockchain, has intoxicated investors around the world and is now making tentative inroads into science, spurred by broad promises that it can transform key elements of the research enterprise. Supporters say that it could enhance reproducibility and the peer-review process by creating incorruptible data trails and securely recording publication decisions. But some also argue that the buzz surrounding blockchain often exceeds reality, and that incorporating the approach into science could prove expensive and introduce ethical problems.

A few collaborations, such as Scienceroot and Pluto, are already developing pilot projects to use blockchain for science. Scienceroot aims to raise US$20 million, which will help to pay both peer reviewers and authors within its electronic journal and collaboration platform. To draw in this money, it plans to exchange some of the 'science tokens' it uses for payment for another digital currency, known as ether, starting in early 2018. And the algebra program Wolfram Mathematica — widely used by researchers — is currently working towards offering support for an open-source blockchain platform called MultiChain. Scientists could use this, for example, to upload data to a shared, open workspace that isn't controlled by any specific party, according to MultiChain.

Blockchain, a technology that creates an immutable public record of transactions, has a "Wild West, boom or bust culture", says Martin Hamilton, a London-based resident futurist at Jisc, which supports digital services in UK



SEUNG-IL RYU/NURPHOTO/GETTY

Mining for bitcoins creates a large computational demand.

education. He warns that academics and entrepreneurs might be tempted to add the technology solely to make their projects seem "magical and sparkly". As one sign of this trend, consulting firm Deloitte has identified more than 24,000 aborted, largely financial blockchain projects on the GitHub software-development platform in 2016 alone. Yet Hamilton still says blockchain has incredible potential. "There will be things that we try which simply blow up in our faces," he says. "But the rewards can be huge, if you're willing to take a calibrated risk."

Blockchain underlies cryptocurrencies such as Bitcoin, which is traded as units called bitcoins with a lowercase 'b'. It is created by a community of 'miners', who run Bitcoin software on their hardware and compete to discover a hard-to-find number by trial and error. The victor of this contest adds an encrypted block of transactions to the chain and earns a financial reward. They communicate the extended blockchain to all other miners, and the process starts again.

FOOLPROOF TRACKING

Mining takes a lot of computation, which makes it unlikely that any individual will win twice in a row. This is crucial, because if miners could add more than one block at a time, they could gain power over the record and even discard earlier blocks they had added. That would effectively refund their transactions and enable them to spend the same bitcoins again. In 2016, a consortium of miners highlighted ▶