soon decide whether it will help to pay for the pilot demonstrations. "It certainly is possible that the board will say yes to this, but there's no guarantee," he says. As data roll in, SAGE will review its position: a final decision on whether to recommend deploying the vaccine more widely could come during this period.

Even if that happens, it is not clear what the uptake would be. Although African malaria-control officials welcome RTS,S, they say that they would need more funding to deploy the vaccine. Budgets for malaria prevention and treatment using measures such as insecticide-treated bed nets and artemisinin-combination therapies are already stretched thin.

GSK says that it will charge $1–10 per shot, covering the company's manufacturing costs and a return of 5%, to be reinvested in new vaccines for malaria or other diseases that are common in the developing world. But funding will also be needed to deliver the vaccine to children and for programmes to disseminate information. Parents must understand that their children can still get malaria even with the vaccine, says James Tibenderana, development director at the Malaria Consortium in Uganda.

POOR MATCH

SAGE's decision to pilot the vaccine follows the publication of a study on 21 October, which revealed[2] that the vaccine's poor performance in clinical trials is in part because it mimics a strain of the malaria parasite *Plasmodium falciparum* that is not commonly found in Africa.

The vaccine is composed partly of a fragment of circumsporozoite (CS) protein, which is found on the surface of the parasite. People who have been given RTS,S build up some immunity to malaria. But different parasites have slightly different CS proteins — and the study showed that fewer than 10% of parasites infecting some 5,000 children in the trials matched the CS protein in RTS,S. If the vaccine could be re-engineered to include bits of several surface proteins, it would be more effective, says Dyann Wirth, an infectious-disease researcher at the Harvard T. H. Chan School of Public Health in Boston, Massachusetts, who led the 21 October study.

That redevelopment could take years, although some researchers have been discussing the possibility, according to David Kaslow, who oversees the vaccine's development at the non-profit health organization PATH. "It's not trivial to tweak the vaccine to match the prevalent strains in an area," he says, "but it's not impossible."

In the meantime, the advice to run demonstrations of RTS,S sends the right message, says Adrian Hill, a vaccinologist at the University of Oxford, UK. "What the field needs is other players to come forward and accelerate their more modern vaccine candidates." ■

1. RTS,S Clinical Trials Partnership. *Lancet* **386,** 31–45 (2015).
2. Neafsey, D. E. *et al. N. Engl. J. Med.* http://dx.doi.org/10.1056/NEJMoa1505819 (2015).

Ice cores allow scientists to analyse past precipitation and temperature changes.

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CLIMATE SCIENCE

Super-fast drills hunt for oldest ice

Researchers will test machines that can penetrate kilometres in days rather than years.

BY ALEXANDRA WITZE

Drilling through ice sheets is a tedious task. It takes years of fieldwork to retrieve long ice cores that keep a continuous record of the climate stretching back hundreds of thousands of years.

Now there is a faster way to bore deep into Earth's history. Anxious to get to ice as old as 1.5 million years, nearly double the age of the oldest existing core, climate researchers have developed a new generation of 'rapid-access' ice drills. Some of these rigs will face their first major tests during the Antarctic field season that begins this month.

These speedy tools take roughly a week, rather than years, to penetrate several kilometres of ice. They blitz through the topmost layers of ice to reach the ancient freeze beneath, where tiny bubbles of trapped air serve as a time capsule of environments long vanished.

One of the biggest and most ambitious machines, a US project known as the Rapid Access Ice Drill (RAID), is being shipped in November from its construction site in Salt Lake City, Utah, to McMurdo Station in Antarctica (see 'Climate clues'). The British Antarctic Survey will test a much smaller drill, also named RAID (for Rapid Access Isotope Drill) in December at the Sky Blu station on the Antarctic peninsula. French and Swiss research teams are developing their own fast drill designs.

The drills sacrifice detail for speed, however. They chip up or melt the ice as they go, so extracting an intact core is impossible. But these fast drills will be able to do quick surveys of places where researchers might return in future field seasons to extract a full ice core at a more leisurely pace. The US$10.5-million US RAID drill, for instance, is designed to plough through more than 3 kilometres of ice in about a week. That speed would allow it to hop around Antarctica and drill several exploratory holes per season — instead of one hole over several seasons.

Even so, finding the planet's most ancient ice will not be easy. "We're looking for a very fortuitous set of circumstances that allow for

DEEP FREEZE

Antarctica may harbour ice up to 1.5 million years old that could help scientists to understand Earth's past climate.

SOURCE: H. FISCHER *ET AL. CLIM. PAST* **9,** 2489–2505 (2013)

the preservation of very old ice," says Jeffrey Severinghaus, a palaeoclimatologist at the Scripps Institution of Oceanography in La Jolla, California. Ideally, scientists would discover a thick sequence of ice layers, undisturbed by flowing glaciers, that has not been heated too much by the rock below. Possible locations include several of the high-elevation Antarctic ice domes, such as Dome A near to which China's Kunlun research station sits, or Dome C, where European researchers took five years to extract a core that reached into 800,000-year-old ice layers (see 'Deep freeze').

Now researchers want to push even further, to ice that is at least 1.2 million years old. That would provide data on an important shift in Earth's climate, when the planet's glacial cycles changed from being dominated by a 100,000-year pattern to 41,000-year cycles (H. Fischer *et al. Clim. Past* **9,** 2489–2505; 2013).

Knowing what controlled that switch — and whether rising carbon dioxide levels played a part, along with factors such as changes in Earth's rotational tilt — would help scientists to better understand how ice sheets will behave as the world warms. "If we don't understand this we really don't understand the climate that we have today," says Severinghaus.

The US and UK drills take different approaches to reach deep into Antarctica's past. Once the US RAID reaches the bottom of the ice sheet, it could drill up to 50 metres into the underlying rock. Analysing that rock could reveal when it was last exposed to cosmic rays — which, in turn, reveals the age of the overlying section of the Antarctic ice sheet. The first full-scale field trial for RAID is scheduled for 2016–17.

The British RAID is a much more modest project that costs less than £500,000 (US$770,000) and uses a modified conventional ice-core drill. It will be able to penetrate only about 600 metres into the ice sheet, to ice that is 30,000 to 40,000 years old — but unlike the US RAID, it does not require drilling fluid, the weight of which adds considerably to the cost of moving a drill around. "You can't dry-drill deeper than that," says Julius Rix, an engineer who is leading the drill's development. "But there are plenty of places of interest."

A third drill, on a similar scale to the US machine, is the SUBGLACIOR probe being developed at Joseph Fourier University in Grenoble, France. This €3.2-million (US$5.3-million) project aims to melt rather than chip its way through the ice sheet, measuring chemical isotopes of the melted water as it goes, to calculate the age of the ice. The drill would be able to penetrate several kilometres deep; full testing is slated for 2016–17 at the Concordia research station in Antarctica, says Olivier Alemany, a polar engineer at Joseph Fourier University.

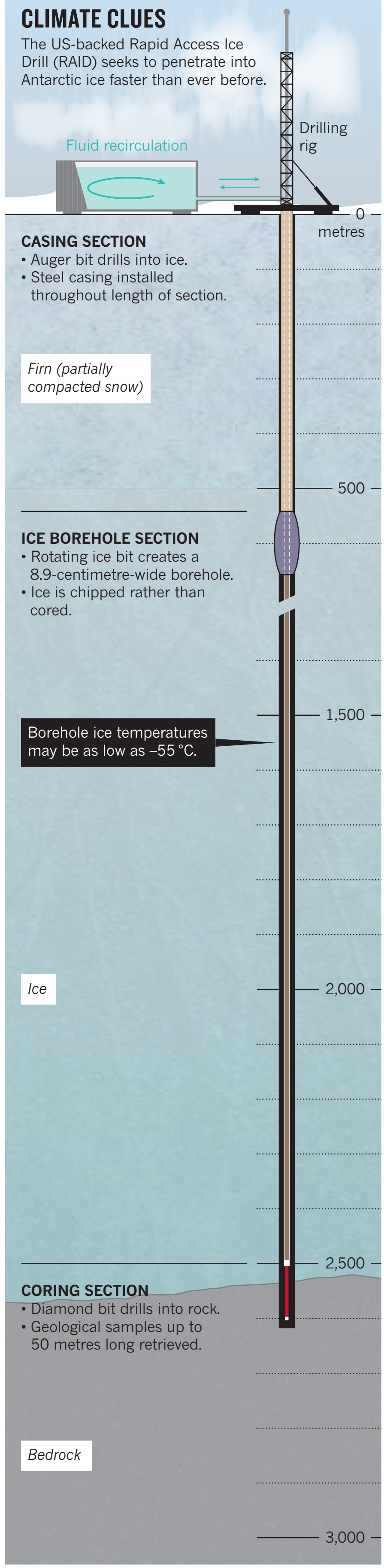
A fourth project, dubbed RADIX, would use a much narrower hole than the others — just 2 centimetres across — to bore up to 3 kilometres in a few days. RADIX has gone through limited testing in Greenland, says team leader Jakob Schwander, a climate scientist at the University of Bern.

No one knows exactly what these drills might encounter when they hit bottom. They might penetrate into pristine lakes below the ice sheet, which microbiologists could explore. Or they might reveal heat radiating upwards from the bedrock, melting the ice in ways that scientists had not expected.

"It's very multidisciplinary," says John Goodge, a geologist at the University of Minnesota Duluth and a project leader on US RAID. "There's all kinds of stuff this fast technology allows that we were never able to have before." ■

CLIMATE CLUES

The US-backed Rapid Access Ice Drill (RAID) seeks to penetrate into Antarctic ice faster than ever before.



SOURCE: US RAID PROJECT

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