



Lake Vostok is one of the largest freshwater lakes in the world: about the area of Lake Ontario, and much deeper. But you have never seen it. Neither has any other human being. That is because it is almost four kilometres under the East Antarctic Ice Sheet, kept liquid by the pressure of the ice above it. And it has been in complete isolation from the rest of the world for millions of years — possibly since before the evolution of mankind.

Vostok is so remote that scientists only became certain of its existence after analysing satellite data in the 1990s, following curious British radar soundings 20 years earlier. It so happened

IN THE EXTREME SOUTH, A TEAM OF DETERMINED SCIENTISTS IN SEARCH OF THE MYSTERIES OF THE DEEP HAVE BRAVED THE COLDEST PLACE ON EARTH

WORDS CHRIS WRIGHT PHOTOGRAPHY ALEXEY EKAYKIN

that it was directly underneath Vostok Station, a facility set up by the Russians in the 1950s.

But we could be on the brink of penetrating this lake for the first time. At the end of this year, a team of Russian scientists and engineers will return to Antarctica to take the last step in a decadeslong effort to drill to the lake. Already, they are just metres away. And when they break through, the secrets of the most pristine wilderness on Earth will be revealed — a discovery that many in the scientific community wish could be left unmade.

SILENT SECRET

The Russians, without knowing there was a lake there, had been conducting deep drilling for ice cores since the 1970s. Once they knew of its existence, they stopped in 1998 amid concerns about contaminating the lake. Progress was halted for eight years of debate with the international community, but drilling resumed in 2004 and in February 2011 reached 3,720 metres, probably about 50 metres from the surface of the lake. Then, tantalisingly close, they had to fly out on the last plane before winter set in.

"This is the largest subglacial lake in the world," says Valery Lukin, head of the Russian Antarctic Expedition. "We know the character of its coastline, the thickness of the ice sheet, the water and the sedimentary rocks."

He is of the opinion that Lake Vostok has been untouched by any external forces for many millions of years. "I believe the lake was formed before the glaciation epoch in the Antarctic, and that took place 35 million years ago," he confides.

No one knows for sure, but it is possible to generate an educated guess about what the water is like: Lukin believes there is an upper layer of fresh water, and beneath it a layer of mineralised water, with geothermal activity beneath it.

"We assume the surface layer is extremely rich in dissolved oxygen, a situation which can kill living things," he says, referring to something known as oxygen toxicity. But not the layer beneath. And that is where things get interesting.

Ice cores taken from above the lake, formed from frozen lake water below, not glaciations above, have shown some very strange findings. "In the cores we have detected bacteria: the same sort of bacteria which inhabit very hot water," Lukin explains. It is similar, he says, to bacteria found in the geysers of Yellowstone National Park in the US, or the smoking underwater cones along the mid-Atlantic ridge.

Definitely not what one would expect to find at the site: Vostok Station is home to the lowest temperature ever recorded on Earth, 89.2 degrees Celsius below zero.

CAST IN ICE

Reaching the lake, and learning from it, is bringing together an eclectic cast of characters. Lukin, who has headed the Russian Antarctic Expedition for 21 years and has had direct involvement with Vostok since 1994, spent the first 20 years of his career as an oceanographer, once leading a pioneering US-Russian expedition to the Weddell Sea that established a station on drifting ice. Today he is more of an administrator, coordinating matters from Saint Petersburg in Russia, and unfortunately will not be present at Vostok for the breakthrough.

The team on the ground is typically of 10 people, eight drillers and two glaciologists, who will work in shifts 24 hours a day on the drilling. If work stops, the drill freezes in the borehole.

The man in charge of the drill, and of all operations on the ground, will be Dr Nikolay Vasiliev, a drilling specialist from the Saint Petersburg State Mining Institute in Russia. The two glaciologists in the team assist the drillers with knowledge about the ice and examine the cores.

"I make preliminary measurements to determine the total length of the ice core, and the depth of the borehole," says Dr Alexey Ekaykin of the Arctic and Antarctic Research Institute, glaciologist and member of the Russian expedition. "Then I cut the ice core into samples, and measure properties," he explains. These properties include electrical connectivity, constituents, contaminants and acidity.

Another key personage in the research team is Dr Sergey Bulat, a molecular biologist from the Petersburg Nuclear Physics Institute, in Russia. He is there for the bugs. Pulling bacteria out of an ice core is a treacherous business: there is the constant risk of contamination from drilling fluid and, once the core has been extracted and is on the surface, from the handling of the ice core.

Bulat created a database of contaminants so as to be able to eliminate them when examining samples. It is through his approach that we know about the hot spring-like bacteria in the lake, suggesting hydrological activity and the likelihood of life.

"If we find something, it will be a real discovery," says Ekaykin. "On the other hand, we do not know of any ecosystem on our planet which does not contain any kind of life. So if we do not find anything in the lake, that is also a great discovery." A fantastic Christmas gift, indeed.

SCIENTISTS BELIEVE THAT LAKE VOSTOK HAS BEEN UNTOUCHED **BY EXTERNAL FORCES** FOR MANY MILLIONS **OF YEARS**

NO-RUSH RUSSIANS

"For me, I am not in a hurry," says Dr Alexey Ekaykin of the Russian expedition. "If we have to prepare for one more year, that's not a tragedy at all." He manages to make life at this most desolate of locations sound bearable. "It's not that harsh in the summer. Minus 15 to 20 [degrees Celsius] in the daytime, only minus 25 [degrees Celsius] at night. And it's not very windy.' That's good then; no need for a hat.



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OF A GIANT SNOW PLOUGH

DRILL **BITS**

THERE ARE AT LEAST 150

SUBGLACIAL BODIES OF WATER UNDER ANTARCTICA - AND MANY OF THEM MAY BE LINKED

280KM LONG AND BETWEEN 30 AND 70 KILOMETRES WID

ON AVERAGE LAKE VOSTOK I **300M**

DEEP BUT AROUND ONE KILOMETRE AT ITS DEEPEST POIN - ONE OF THE DEEPEST LAKES IN THE WORLD. LAKE BAIKAL, IN SIBERIA, RUSSIA, IS THE DEEPEST AT 1.700 METRES DEEP



WHICH IS HIGHER THAN THE EIGER IN THE SWISS ALPS

AKE VOSTOK IS BELIEVED TO



- BELOW THE USUAL FREEZING POINT OF WATER. IT REMAINS IN ITS LIQUID FORM BECAUSE OF HIGH AMOUNTS OF PRESSURE FROM THE ICE ABOVE IT

IT HAS BEEN ARGUED THAT EXPLORING VOSTOK WILL HELP US UNDERSTAND CONDITIONS ON JUPITER'S MOON OF EURO WHICH IS BELIEVED TO HAVE A SUBSURFACE OCEAN

HE COLUMN OF KEROSENE AND



12KM

IOT AS A NORMAL DRILL BIT AN COPE WITH



LEFT: RESEARCH IN THE ANTARCTIC WILL KEEP YOU ON YOUR FROZEN TOES, WITH THE HARSH CONDITIONS AND EXTREME ISOLATION. BUT WITH THE LURE OF UNDISCOVERED KNOWLEDGE, MANY SCIENTISTS RETURN SEASON AFTER SEASON PAGE 103: VOSTOK STATION'S THREE DRILLING TOWERS



WHEN THE RUSSIANS **BREAK THROUGH TO** LAKE VOSTOK, THE SECRETS OF THE MOST PRISTINE WILDERNESS ON EARTH WILL BE REVEALED

THE OLD, COLD QUESTION

European, American and Japanese. The first two are more or less the same and use a mixture of kerosene and Freon as drilling fluids, whereas the American system uses hot water - the system experts of the Antarctic and Southern Ocean Coalition (ASOC) would rather see used

Lukin disagrees. "I am certain hot water drilling is more harmful, and brings more contaminants, into the sub-glacial lake," he says. He explains that when the drill finally breaks through to the water's surface, it will immediately be withdrawn, and pressure will push lake water up the borehole. Since kerosene and Freon are lighter than water, and cannot mix with it, the contaminants will not enter the lake. Lukin cites the accidental breach of a sub-glacial lake in Greenland by Danish drillers, who were also using kerosene, as an illustration the technology works.

depth. "The properties of the ice are changing as the temperature changes and we approach melting point," says glaciologist Ekaykin, who has served on previous research teams. Lukin says crystals at Vostok can reach three metres in diameter. "Nobody in the world has faced crystals of such size," he says. "It is very difficult." Indeed, in an event that worries environmentalists, a drill was irretrievably lost during drilling in October 2007. A new divergent borehole had to be sunk for work to continute and that original drill is still there, trapped in the ice.

THE ROAD TO EL-DORADO

This month, the team of drillers and scientists will begin a long, long journey south by ship, plane and land from Saint Petersburg, first to Cape Town, then to Novolazarevskaya Station near the Antarctic Coast, then to Progress Station in Antarctica, and finally on to Vostok. "We will spend some time reactivating the borehole and installing new instrumentation in the drill system," says Lukin. "In the beginning of January we will start the drilling operations proper. We believe we will be successful this season.

secrets. When the water rushes from the lake into the borehole, it will swiftly freeze. It will probably be the next season, 2012 to 2013, before the team can go back, extract a core and learn about the lake's secrets. Then the following season, the intention is to lower some measurement systems into the lake to learn more. That, says Lukin, is when they should finally discover if there is life down there — possibly of a sort never encountered before

the ethics of the program will rage long after breakthrough takes place, but the Russians are not cowed. "It is human nature that we want to explore unknown objects," explains Ekaykin

Lukin has a different take. His interview has been conducted through a translator, but when the contamination issue is discussed, he speaks directly in English. "Tell me," he asks. "Did the Americans worry about contamination when they went to the moon? Please write th

There are four methods of deep drilling in the world: Russian,

The drilling itself has become a lot more difficult at greater

But even after the final breakthrough, Lake Vostok will keep its

The Russian team is trying to remain upbeat. Arguments about



TIME TRAVEL

The Russians are not the only group drilling in Antarctica. Recent attempts have been led by New Zealand, from Scott Base, the most significant being ANDRILL, a collaborative effort between New Zealand, Germany, Italy, the UK and the US.

Involving more than 200 scientists and researchers so far, this project's mission is to drill back in time: it extracts cores to reveal the history of glacial and interglacial changes that have taken place in Antarctica - and to help to model scenarios of future global warming.

Antarctica New Zealand manages ANDRILL operations and logistics, while the scientific research is coordinated by the University of Nebraska-Lincoln, in the US. In 2006 and 2007, near McMurdo Station, it drilled and recovered two cores of up to 1,200 metres, representing around 20 million years of geological history. Scientists have been analysing the cores ever since, and have learned that the West Antarctic Ice Sheet was much smaller during a period of warm global climate that is "similar to those projected to occur within the next 50 to 100 years," says Dr Richard Levy, ANDRILL scientist and paleogeological expert.

The researchers are now preparing to drill back to depths reflecting 24 to 45 million years ago at a new project called Coulman High Drilling for this is expected to begin in 2014 to 2015.

The ANDRILL project uses hot water drilling, as opposed to the kerosene and Freon mix used by Russians. At Coulman High they will melt a hole through the Ross Ice Shelf, which is several hundred metres thick. "We melt snow to produce the initial water required to melt a hole through the ice shelf," Levy says. Seawater is pumped down to maintain an open hole once the drill has penetrated the ice shelf. and a steel pipe is lowered through the hole to the sea floor, to <u>accommodate the</u> next stage of drilling.