# Deep science strikes gold after latest site is named

In the world of underground science, space is tight, and getting tighter. So scientists across the globe are welcoming a proposal for a new US facility that could help relieve the growing subterranean real-estate crisis.

On 10 July, the US National Science Foundation (NSF) announced that it had selected the abandoned Homestake gold mine near Lead, South Dakota, as the preferred site for a US$500-million Deep Underground Science and Engineering Laboratory. If fully funded, the mine will be developed into a sprawling underground campus — the deepest yet — where geologists, microbiologists and physicists can ply their trade.

**"There is no more empty space."**

It is physicists in particular who want the space, and who have been driving the push for the new lab. For decades, they have travelled to road tunnels and abandoned mines to build experiments that must be shielded from cosmic radiation. Only a handful of locations can host the searches, and many are becoming overcrowded, says Eugenio Coccia, director of the world's largest underground facility, the 180,000-cubic-metre Gran Sasso National Laboratory near L'Aquila, Italy. "There is no more empty space," he says.

In the United States, the situation is even worse, says Bernard Sadoulet, a physicist at the University of California, Berkeley. America's only major underground facility is at the Soudan mine in Minnesota, and Sadoulet, who co-chaired a review of underground science for the NSF, says his committee received around 80 letters of interest in the new lab.

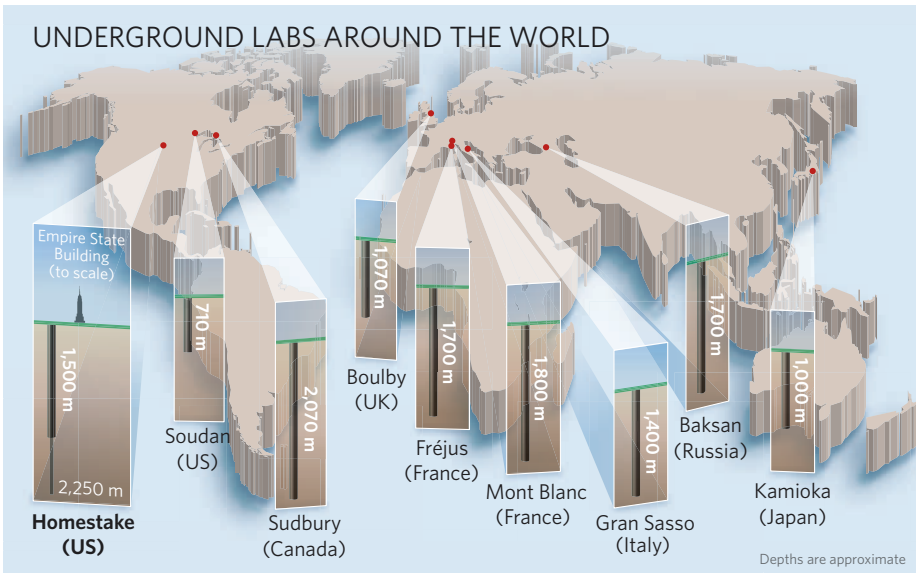
Then there is the problem of depth: the Soudan mine is 710 metres deep, but most of the newer experiments need to go deeper. Sadoulet's own experiment at Soudan probes dark matter — particles that interact only rarely but make up roughly a quarter of the mass of the Universe (see page 240). He says the next generation will be ready before Homestake and will be sited at the 2,070-metre-deep Sudbury Underground Laboratory in Ontario, Canada.

Such physics is being driven ever deeper underground. As particle accelerators increase in size and cost, rare-event physics of the sort that can be done only beneath thousands of metres of rock is seen as an increasingly attractive means of probing big questions. For instance, a phenomenon known as neutrinoless double-beta decay, an extremely rare event that occurs during the decays of some nuclei, could prove that neutrinos are their own antiparticle. Such a finding would have implications for the standard model of particle physics, and could explain why there is more matter than antimatter in the Universe today.

The search for these rare processes typically requires that detectors sit for years gathering just a handful of events. With each generation, the detectors get bigger and the experiments get longer. Thus, many existing underground laboratories are planning expansions. Proposals are on the table to expand the Fréjus laboratory in France in 2012, says Gilles Gerbier, a physicist at the French Atomic Energy Commission in Saclay. And the Kamioka Observatory in Japan, which hosts the massive Super-Kamiokande neutrino detector, is also digging new spaces for a dark-matter search and double-beta-decay experiment, according to Yoichiro Suzuki, the observatory's director.

The need for increased sensitivity of such experiments also sends them deeper, because each successive metre of rock gives more effective shielding from disruptive cosmic rays. The world's two deepest laboratories, Mont Blanc in France and the Sudbury mine in Canada (see graphic), are cramped. Even after an expansion at Sudbury planned for completion by 2008, there will be room for only four large experiments, says Arthur McDonald, a physicist at Queen's University in Kingston, Ontario. "We've had more letters of interest than we've space to house the experiments," he says.

Homestake would also provide opportunities for geologists and microbiologists. Geologists could use it to study how rock behaves under pressure; such information may help to understand earthquakes. Meanwhile, microbiologists see the lab as an opportunity to study organisms that live far beneath Earth's surface. "Most of these organisms don't depend on oxygen to survive," says Tullis Onstott, a geomicrobiologist at Princeton University in New Jersey. What nutrients they need, and how they obtain them, could provide clues to how life began, he adds.



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M. C. ESCHER

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**The abandoned Homestake gold mine will host the world's deepest underground lab.**

If approved, the Homestake lab will have campuses at 1,500 and 2,250 metres below the surface, with cavities 50–60 metres in diameter. That would be big enough to handle detectors for the most ambitious searches, says Kevin Lesko, head of the Homestake collaboration and a physicist at Lawrence Berkeley National Laboratory in California. "I'm very excited," he adds.

The selection of Homestake caps a long and highly politicized process. It was first put forward as a candidate in 2001, quickly winning the backing of powerful local politicians such as Senator Tom Daschle, who was then Democratic minority leader. In 2005, the NSF announced that Homestake and a Colorado mine were the finalists for hosting the underground lab, but protests from losing teams caused the process to be reopened.

Even now, there is no guarantee that the Homestake lab will be built. Local billionaire T. Denny Sanford, together with the state of South Dakota, have pledged some $100 million for an interim site at 1,500 metres, but the deeper facility will require NSF construction money. At present, the agency has approved just $15 million for a three-year, detailed design study. To win full funding, the design must go before the independent National Science Board, where it will compete with other large projects.

Even so, researchers are pleased that the first steps have been taken, and are hopeful that the lab will be built. "It's clear where the science is going," says Sadoulet. "The frontier is deep." ■

**Geoff Brumfiel**

# Russia pins its hopes on 'nano'

**MOSCOW**

**In what could be the biggest windfall for science since the collapse of the Soviet Union, the Russian parliament last week gave the green light to a massive US$7-billion investment in nanotechnology over five years. The Russian government hopes the programme will make the country a world leader in nanoscale technologies with a wide range of military and civilian uses.**

**However, the move has been criticized as poorly prepared and unlikely to yield results.**

**Nano-devices, designed from single atoms and molecules, are predicted to have applications in fields as diverse as consumer electronics and biomedicine. All research and development activities will be coordinated by Rosnanotekh, a new tax-exempt body with far-reaching freedom to set up institutes, put work out to tender and commercialize results.**

**But no details have been announced about the precise structure, goals and content of the initiative. It is unclear, for example, how projects will be selected for funding.**

**Some Russian scientists, sceptical about fair allocation of funds, have given the announcement a lukewarm response. The country has hardly any competence in nanotechnology, they say. And given the widespread absence of efficient quality control in Russian science funding, many fear the scheme will be poisoned by corruption.**

**"Our government just doesn't understand anything about science," says one high-level Russian physicist who asked not to be named. "They think if they throw enough money at it they'll get some nice exploitable results in return. But we don't even have the experts."**

**"Lack of transparency and programme abuse are the usual Russian dangers."**

**The programme is the brainchild of Russian President Vladimir Putin, who is keen to reduce the country's dependence on oil and gas.**

**Putin recently compared the importance of nanotechnology to that of nuclear science. He is said to have secretly recruited Mikhail Kovalchuk, the director the Kurchatov Institute in Moscow, to head Rosnanotekh.**

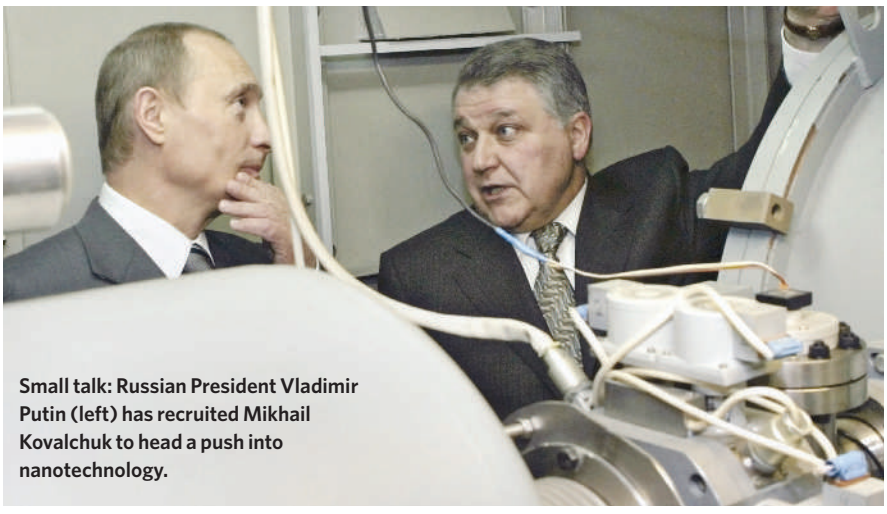
**Kovalchuk, who is not an expert in nanotechnology, is the brother of Yuri Kovalchuk, a banker and businessman with close ties to Putin.**

**The independent Russian media has poured scorn on Russia's foray into what some call the "banano" technology business. "Lack of transparency and programme abuse for personal goals are the usual Russian dangers," says former science minister Boris Saltykov, an expert in science management.**

**"Risks do exist," agrees Alexander Nekipelov, vice-president of the Russian Academy of Sciences in Moscow. "But the money involved is so huge that scrutiny will be very good this time."**

**The academy is keen not to be bypassed by the programme, for which the government has set aside more funds than the entire academy receives. In a move that critics say violates its own rules, in June the academy leadership appointed Kovalchuk, who is not a full member, as acting vice-president for nanotechnology.** ■

Quirin Schiermeier



M. KLIMENTYEV/RIA NOVOSTI/PRESIDENTIAL PRESS SERVICE/AP

**Small talk: Russian President Vladimir Putin (left) has recruited Mikhail Kovalchuk to head a push into nanotechnology.**