

China Takes Bold Steps Into Antarctic's Forbidding Interior

Increased spending and ambitious plans for exploration aim to strengthen China's foothold in the polar regions

BEIJING—Covered by the East Antarctic Ice Sheet, the Gamburtsevs are probably the least explored, and most poorly understood, mountain range in the world. It's not for lack of scientific interest: According to climate models, the 600-km-long Gamburtsev range is the likely birthplace of the ice sheet that formed some 30 million years ago, and the mountains hold important clues about geological and climatic forces in the region that have shaped global change over the eons. But their inaccessibility—thanks to a 1000-meter-thick blanket of ice combined with the harshest weather on the planet—has allowed them to retain vital geological secrets such as their age, composition, and topography. Their very existence—a 3600-meter-high formation far from the edge of any tectonic plate—is a major mystery.

This week a team of Chinese polar scientists set out on a journey to lift that veil of secrecy. It's the first step in a plan to build a permanent station at Dome A, the highest, driest, and coldest spot on the continent. Once the station is completed, in 2008, the scientists plan to outfit it with instruments that can make use of those inhospitable conditions to gaze into the distant universe, monitor the polar upper atmosphere, extract ice cores, and drill through the ice sheet to the underlying bedrock.

Their 1200-kilometer trek inland from China's Zhongshan station on the continent's east coast is part of the country's broader commitment to polar research that includes a new Arctic station, an expansion of its two existing Antarctic stations, an upgraded research ship, new support facilities, and ultimately a new home for its premier Polar Research Institute of China (PRIC) in Shanghai. Chinese officials hope that an extra \$64 million over the next 3 years, doubling the current annual polar science budget of roughly \$20 million, will also lift the country into the major leagues of polar research in time for the high-profile International Polar Year (IPY) in 2007 (*Science*, 5 March, p. 1458).

News of these ambitious plans, which has dribbled out over the past several months, has generated a buzz in the polar research community. "It's like manna from heaven," says Christopher Rapley, director

of the British Antarctic Survey and chair of the IPY planning committee, who learned about the details earlier this month at an international conference in Beijing marking the 20th anniversary of China's first scientific foray into the polar regions. "It's the biggest financial commitment to IPY to date



Crunch time. Zhang Zhanhai, director of the Polar Research Institute of China, with the ice-capable *Xue Long* during an Arctic expedition.

from a government, and I hope that it will stimulate other countries to do the same."

Rightful interests

Like most government-supported research in China, the value of polar research is seen in geopolitical as well as scientific terms. This summer, for example, President Hu Jintao hailed the opening of China's first permanent arctic research station in Svalbard, Norway, by exclaiming that it "would open important windows to scientific exchange with other countries" as well as help discover "natural secrets that will benefit both current and future generations." The country's 5-year plan for polar research justifies the station, called Yellow River, as a way "to enhance China's influence on issues concerning Arctic research and protect its rightful interests."

Those interests are quite broad. At the Beijing conference, PRIC Director Zhang

Zhanhai described three overarching research themes that will drive China's efforts for the rest of the decade. One involves the Antarctic continent, including the construction of a Dome A station and installation of environmental monitoring systems throughout the vicinity, drilling into the Gamburtsevs, and exploring the variability of the coupled (air-sea-ice) climate system along the Amery Ice Shelf and throughout the Southern Ocean. A second theme focuses on exploring various upper atmospheric phenomena, with scientists combining observations taken at the Zhongshan, Dome A, and Yellow River stations. The third examines

the factors contributing to rapid climate change in the Arctic, making use of the new Svalbard station. Each activity is connected to an existing global polar initiative, says Zhang, who adds that China welcomes foreign collaborators on any and all projects.

The Gamburtsev drilling project is probably China's best bet to carve out a niche for itself in the polar regions. Most of the country's scientific work to date has been derivative, notes Dong Zhaoqian, the former director of PRIC, who led China's first Antarctic expedition in 1984. But the Gamburtsevs are virgin territory. Obtaining samples and doing on-the-ground measurements would be a real coup, say geologists. "It would be a big scientific advance," says Slawek Tulaczyk of the University of California, Santa Cruz, an expert on subglacial drilling.

The Chinese team faces formidable challenges, to be sure, beginning with the logis-



Spanning the globe. China's new Yellow River station in Svalbard, Norway (inset), will bolster studies of polar lights and other upper atmospheric phenomena being conducted at Zhongshan station in Antarctica.

tics of setting up and maintaining a station to support the multiyear effort. In contrast to the air support that's available to scientists working at the U.S. Scott-Amundsen Station at the South Pole, the Chinese team must lug all their equipment overland. And keeping the hydraulics and electronic equipment in working order during the brutal Antarctic winter won't be easy. But the drilling should be relatively straightforward, says Tulaczyk, aided by the technological advantages of going from cold ice to bedrock without passing through an intervening layer of water. "They're playing it smart," he adds, by picking a place where the ice is relatively thin.

A renovated polar research ship would also enhance China's ability to conduct all kinds of climate change studies. The Snow Dragon (*Xue Long* in Chinese), purchased from Russia in 1993, is China's first ship with ice-breaking capabilities. The spacious (167 meters long) ship is a real workhorse of the country's polar program, serving as both a supply vessel and a research platform. Xiaojun Yuan, a research scientist at Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, for example, has piggybacked on the ship's biannual visits to Zhongshan and China's Great Wall station on King George Island to take measurements of salinity and temperature in an understudied portion of the Southern Ocean. She hopes to get one more set of data this season from the project, funded jointly by China's Arctic and Antarctic Administration and the U.S. National Science Foundation, before the ship goes into dry dock. "It's filling a gap in the global picture of interannual sea variability," she says.

But its equipment dates from the 1980s, and the \$20 million upgrade would give it a modern navigational system, more lab space, and the ability to accommodate two helicopters. At the same time, the government has pledged \$20 million to provide a dedicated berth and warehouse facilities for the ship, and there is talk of eventually moving PRIC to the new site, too. There's also an effort to drum up support for a second research vessel, a domestically built ship that

would be smaller and better suited to work in the open ocean.

The additional funding is also expected to draw scientists into the field, a step that Rapley and others say is necessary if China hopes to take advantage of its improved

scientific infrastructure. "This gives them the opportunity to really ramp up their capacity," he says. Jihong Cole-Dai, a geochemist at South Dakota State University who has worked with PRIC scientists on Antarctic ice cores, agrees that "they need more people" to broaden their work at the poles. But he predicts that "if the decision [to make polar research a priority] has been made, then the resources will be provided."

The increased support can't come soon enough for Chinese polar scientists. "Sometimes when foreign researchers talk about joint operations, we just shy away because we're unable to raise our share of the funds," says one scientist who requested anonymity. "But now I'm feeling more optimistic."

—YANG JIANXIANG

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Profile Susan Herring

Getting Inside Your Head

Drawing on the latest technology, Susan Herring is revealing how the push and pull of muscles and other forces shape skulls

Sue Herring ponders weighty matters. To be more specific, this functional morphologist at the University of Washington (UW), Seattle, probes how skull bones respond to weight, pressure, and other forces. During her 30-year career, she's brought increasingly sophisticated approaches to bear on this question, achieving an ever more precise accounting of how physical factors shape the overall skull. While chewing exerts one such force, there are many others that compress, tug, and push on skull bones.

Unlike arm and leg bones, which are relatively straight and simple in design, the skull's bones curve and twist so as to mold around the developing brain and set up the scaffolding that muscles need for chewing, smiling, or snarling. Genes and proteins only go so far in shaping a skull, according to Herring. She and others have found that the forces inside the skull, created by the expanding brain, the tongue, or head muscles, also influence skull bone growth and continue to modify these bones throughout life. "We think of skeletons as being permanent, but they are really dynamic," she says.

Herring's experiments have corrected misconceptions about the jaw and other parts of the skull that she and many others have long had—and in doing so, her data have found practical use. She has recently revised the traditional view of the nasal septum, the wall of cartilage and bone between the nostrils, and

inspired new thoughts about the design of prosthetic jaws. Her work "has great applications in terms of dentistry and medicine," says Anthony Russell, an evolutionary morphologist at the University of Calgary, Canada.

Many little pigs

Herring's fascination with skulls began as a graduate student at the University of Chicago during the 1960s after she had studied the distinctive head shapes of the warthog and other pigs. She decided to focus on the source of the differences. At first, the work "wasn't very satisfactory," she recalls. Herring dissected and measured jaw and facial muscles and compared her pig skulls to those of fossil pigs, getting ideas about how muscles had shaped the skulls. But she had no way to test whether her ideas were correct.

She persevered, focusing on a miniaturized pig breed, which gave her insights into the human skull. Both pigs and people, she notes, are omnivores, and the chewing forces that shape their jaws and buffer their skulls and brains are similar.

In 1971, Herring moved to another Chicago school, the University of Illinois, where she began measuring the electrical activity of moving jaw muscles. At the time, she recalls, "I didn't really understand the way muscles move the jaw" for biting or for changing facial expressions. When animals chew, they move their jaws side to side to enable teeth to grind

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