

VOLCANOLOGY

Is China's Riskiest Volcano Stirring Or Merely Biding Its Time?

CHANGBAI MOUNTAIN, CHINA—On the north slope of Changbai Mountain, throngs of tourists jostle at a precipice to catch a glimpse of Sky Pond, the volcano's huge caldera lake several hundred meters below. For Koreans who revere this mountain on the border of China and North Korea as the birthplace of the Korean nation, no pilgrimage is complete without a peek at Sky Pond.

They'd better enjoy the view while it lasts.

Last month, a South Korean geologist declared that the 2744-meter-tall volcano, known as Mount Paektu to Koreans and Tianchi caldera to Chinese, is showing signs of waking from a century-long slumber. North Korean scientists, too, are worried about recent geophysical anomalies observed at the mountain, *Science* has learned. But Chinese volcanologists, who have a sophisticated monitoring system set up at Changbai, discount the threat and insist that the volcano is quiet. South Korea plans to hold a meeting with China and Japan in November to "get to the bottom of the matter," says an official with the Korean Meteorological Administration (KMA) in Seoul who requested anonymity

because of the issue's sensitivity.

An eruption of Changbai could have devastating consequences. Of China's 14 active volcanoes, "Changbai poses the biggest hazard and therefore is our most dangerous one," says Xu Jiandong, director of the China Earthquake Administration's (CEA's) Active Volcano Research Center in Beijing. Part of the risk is the threat of lahars from the huge lake in the 5-kilometer-wide caldera. About 100,000 people live on or near Changbai's slopes, and in summertime the region is packed with tourists.

As volcanoes go, Changbai is in the big leagues. In a violent, explosive eruption around 1000 C.E.—dating is not precise, so it's called the "millennium eruption"—the volcano disgorged up to 30 cubic kilometers of magma, or 10 times as much as the famed Krakatoa eruption in 1883. Pyroclastic flows covered an area extending roughly 50 kilometers from Tianchi caldera. In the past 2000 years, only the 1815 eruption of Tambora in Indonesia rivals Changbai, which dumped ash as far away as northern Japan, says Tsuyoshi Miyamoto, a geologist at

Tohoku University in Miyagi, Japan, who has studied past eruptions at Changbai. Smaller eruptions have occurred at roughly 100-year intervals since then, with the last one in 1903.

At a KMA seminar in Seoul last month, Yun Sung-hyo, a geologist at Pusan National University, citing Chinese data, said signs indicate "that Mount Paektu may have an eruption in the near future," according to a report by Yonhap News Agency. And in recent months, North Korean geologists who monitor the volcano have sought cooperation with Western volcanologists, including a joint expedition to the volcano, training abroad for North Korean scientists, and upgrades to a research station at Paektu, says a North Korean official who requested anonymity. No cooperation has yet gotten off the ground.

Chinese volcanologists keep a close eye on Changbai; they say an eruption does not seem imminent. From 2002 to 2005, the volcano's magma chamber evidently was filling, says Xu. In quiet periods, seismometers register about 100 small tremors a year around the mountain, he says. In 2003, Changbai-shan Tianchi Volcano Observatory recorded 1293 tremors. By 2006, the frequency had receded to background rate, and in the first 6 months of 2010 the station recorded 58 tremors. The mountain rose about 6.8 centimeters in 2003 and 2004, and the ratio of helium-3 to helium-4—"a good indication

HIGH ENERGY PHYSICS

Fermilab Physicists Don't See Higgs, Argue They Should Keep Looking

PARIS—This year's International Conference on High Energy Physics was a case study in irony. The meeting was billed as the coming-out party for the Large Hadron Collider (LHC), the gigantic European atom smasher that started taking data in March, but the buzz surrounded results from the older Tevatron collider at Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois. Quelling rumors, Fermilab physicists said they had *not* yet spotted a long-sought particle called the Higgs boson. Nevertheless, their improved nonobservation has them pushing to run the Tevatron three extra years, through

2014—a plan that officials at Fermilab itself do not necessarily favor.

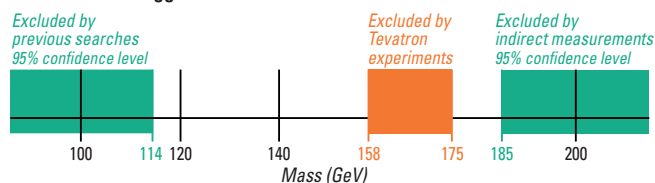
Higgs bosons lurking "virtually" in the vacuum are thought to drag on other particles to give them mass. But physicists' standard model of the fundamental particle does not predict how much the Higgs itself will weigh, so scientists must search for it. Physicists know from previous experiments that the Higgs most likely weighs between 114 and 185 giga-electron volts (GeV), or between 121 and 197 times as much as a proton. Last year, Fermilab researchers showed that it likely does not weigh between 162 GeV and 166 GeV. Now, they've widened that "exclusion window" to between 158 GeV and 175 GeV (see figure).

That advance suggests that Fermilab researchers have nearly enough data and sen-

sitivity to spot the Higgs if it's anywhere in the 114-to-185-GeV range, says Fermilab's Dmitri Denisov, co-spokesperson for the 500-member team working with the D0 particle detector. "Everywhere, we are very, very close," he says. If the Tevatron smashed protons into antiprotons through 2014, researchers would collect 65% more data than they will have by the end of next year. That should be enough to glimpse the Higgs—if it's there—before physicists at the LHC can. "There's definitely a window of opportunity here," Denisov says.

That's because the LHC, housed at the European particle physics laboratory CERN near Geneva, Switzerland, will shut down at the end of 2011 to repair thousands of unreliable solder connections between its superconducting magnets. In September 2008, the LHC broke down during preliminary tests when one of those connections melted. After 14 months of repairs, CERN officials decided to run the accelerator at no more than

Search for the Higgs Particle



Where it's not. Fermilab's new limits on the mass of the Higgs boson.



Living dangerously.
Tourists peer over the rim
of Tianchi's caldera.

of magma activity because the source is the mantle," Xu says—nearly doubled during that time. Changbai has been largely quiet since 2005, says Xu, who expects it to kick into another "active phase" again in the next few years. "But that doesn't mean it will erupt," he says. Miyamoto agrees and notes that it is extremely unlikely that the next eruption would rival the millennium eruption.

Korean scientists are wary. One bone of contention is data sharing. "We can only get earthquake data from China, and it's not real-time," says the KMA official. Data sharing will be a main topic at the tripartite meeting, he says. Xu says that data sharing "is a sensitive question." China will allow foreigners access to data if they "can ensure CEA that it will be used for scientific purposes only,"

he says. Part of the problem is the proximity to the North Korean border. During a visit to Changbaishan Tianchi Volcano Observatory on the north slope of Changbai last week, a staff member declined to answer questions from *Science* on the grounds that "the observatory's work is a state secret."

CEA has proposed a major upgrade of its Tianchi caldera monitoring network to begin next year. One dark spot is the Korean side of the volcano. A few years ago, China proposed building a seismic station for North Korea and integrating observations, says Xu. The offer was declined. "They even didn't want us to build more observatory stations on our side of the border," Xu says. In the meantime, Changbai's magma chamber continues to fill.

—RICHARD STONE

half-energy—still 3.5 times the Tevatron's energy—until all of the suspect connections could be resoldered (*Science*, 12 February, p. 766). That shutdown will stretch to 15 months to allow workers to make other modifications as well, says Stephen Myers, CERN's director of accelerators and technology.

Physicists working with the two biggest particle detectors at the LHC, ATLAS and CMS, say they can overtake the Tevatron experiments with the data they hope to collect by the end of next year. Marat Gataullin, a CMS member from the California Institute of Technology in Pasadena, showed projections that CMS alone would surpass D0 and Fermilab's other particle detector, CDF, in their combined sensitivity to a Higgs weighing more than 135 GeV. But Giampiero Passarino, a theorist at the University of Turin in Italy, says he's skeptical. "By the shutdown? I doubt it."

Running the Tevatron through 2014 would cost about \$100 million, says Robert Roser, co-spokesperson for the 600-member team working with CDF. But finding the money would be tough, especially as the lab is build-

ing a new \$260 million neutrino experiment called NOvA and is developing plans for other projects, says Young-Kee Kim, Fermilab's deputy director: "If we run the Tevatron, then there's a clear impact on NOvA immediately." Still, Kim says, lab officials are taking the proposal seriously.

Some European physicists say they favor running the Tevatron longer. "In an ideal world, I think it would be good to have the Tevatron running in parallel with the LHC," says Guido Tonelli of the University of Pisa in Italy, spokesperson for the 3170-member CMS team. "For the next 2 or 3 years, the two machines will be complementary."

The price may be too high, some Americans say. "I don't see anybody coming along with a check for the \$100 million or whatever it costs to run the Tevatron for 3 years," says Melvyn Shochet, a physicist at the University of Chicago in Illinois and chair of the U.S. government's High Energy Physics Advisory Panel. "So Fermilab has to consider what it's going to give up" to run the Tevatron. Fermilab's physics advisory committee should weigh in next month.

—ADRIAN CHO

ScienceInsider

From the *Science* Policy Blog



Senate Majority Leader Harry Reid (D–NV) declared the effort to pass a **mandatory cap on comprehensive greenhouse gas emissions dead** as he couldn't muster a bipartisan supermajority of 60 lawmakers. *ScienceInsider* interviewed a pollster whose data suggested one reason was ignorance: Many Americans didn't even know what **cap and trade**, the central element of such a limit, was. *ScienceInsider* included post-humorous remarks of climatologist Stephen Schneider on the long effort to pass such a law. And it reviewed a study that said that **federal and state rules already on the books**—if enforced aggressively—would get the United States close to President Barack Obama's stated goal of cutting emissions by 17% by 2005. bit.ly/climatebillcoverage

Italian archaeologists were furious after **archaeological samples turned blue** during storage in a former military facility near Verona. Now a new analysis by mineralogist Gilberto Artioli of the University of Padua in Italy suggests an organic molecule is responsible. He had been asked to analyze the stone tools by archaeologist Laura Longo, the former curator of Verona's Natural History Museum. Longo was suspended without salary recently after she complained about the handling of the artifacts. bit.ly/blueartifacts

Duke University has **suspended three cancer clinical trials** after allegations that a university scientist on the studies embellished his resume, ... while the National Institutes of Health seeks to **close a loophole on a conflict-of-interest rule** that covers scientists changing jobs. bit.ly/trials_halted
bit.ly/looph_nih

A group of scientists who study the coasts have lobbied Thad Allen, who heads the federal response to the gulf oil spill, to halt **coastal engineering projects** intended to protect ecosystems there. Sand berms built in the water to stop oil from striking wetlands have started to erode. A plan to "armor" the berms to halt that problem could be even more disruptive, the scientists say in a letter. bit.ly/oilfixes

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