Geophysical Institute Quarterly

Volume 17: No. 2, 2001

Tapping a Volcano's Mood from Within

A new volcano-drilling project in Japan may help scientists determine if a volcano will erupt with an explosion of ash or with a less-dramatic release of gases and a flow of lava.

Scientists at the Alaska Volcano Observatory often can predict eruptions, but they are not always able to tell if a volcano will erupt in an explosive or effusive manner.

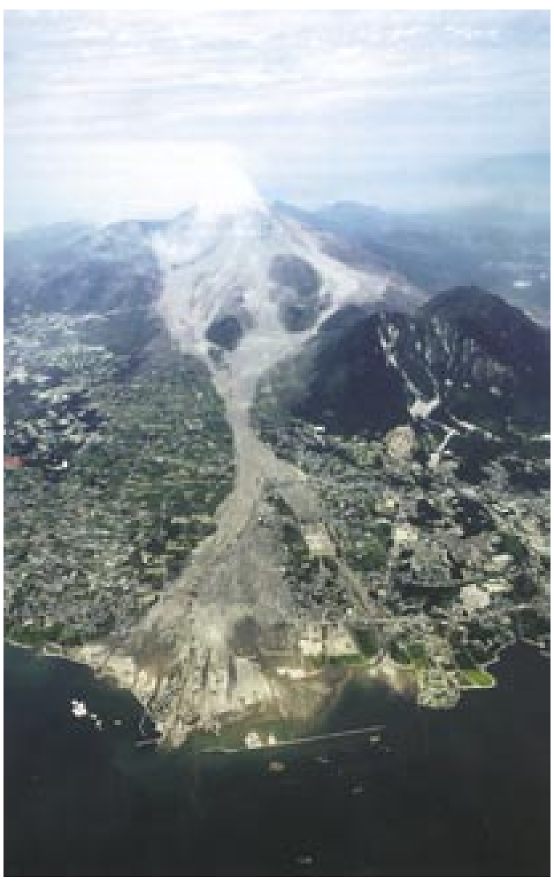
In 1912, Alaska's Mount Katmai exploded. In two days, Katmai spewed more than 30 cubic kilometers of pumice and ash. No eruption has matched its scale since, but explosive eruptions still spew ash into the atmosphere that can ground aircraft, collapse roofs, foul vehicle engines, and make breathing difficult.

By contrast, volcanoes in Hawaii usually erupt effusively, and release a steady flow of lava. Risks associated with effusive eruptions include lava flows and avalanches of rocks in the vicinity of the volcanic vents.

Unzen Volcano in southwest Japan, which erupted effusively from 1991 to 1995, will soon be drilled as part of an international effort to learn more about the internal structure of volcanoes.

PHOTO TAKEN BY S. NAKADA

PHOTO PROVIDED BY S. ARAMAKI



Geophysical Institute Professor John Eichel-berger, Coordinating Scientist for the Alaska Volcano Observatory, is leading the U.S. part of the mission, which is scheduled for 2002.

Unzen Volcano oozed lava at the rate of two cubic meters per second during its four-year eruption. The lava flow created a mountain of unstable hot rocks.

Thousands of avalanches tumbled down the slopes of the mountain during the eruption, killing 44 people and burying 10 square kilometers of the downslope city of Shima-bara.

The international team will attempt to drill into the volcano conduit, the pipe through which magma travels to the surface. The slant-drilling will penetrate 2,000 meters into the volcano's flank, intersecting the magma conduit at 1,000 to 1,500 meters. The conduit is still so hot from the eruption that the drill bit could encounter temperatures of about 600 degrees Celsius.

Above -- A block and ash avalanche flows down the side of Unzen Volcano near the outskirts of Shimabara during the 1991-1995 eruption.

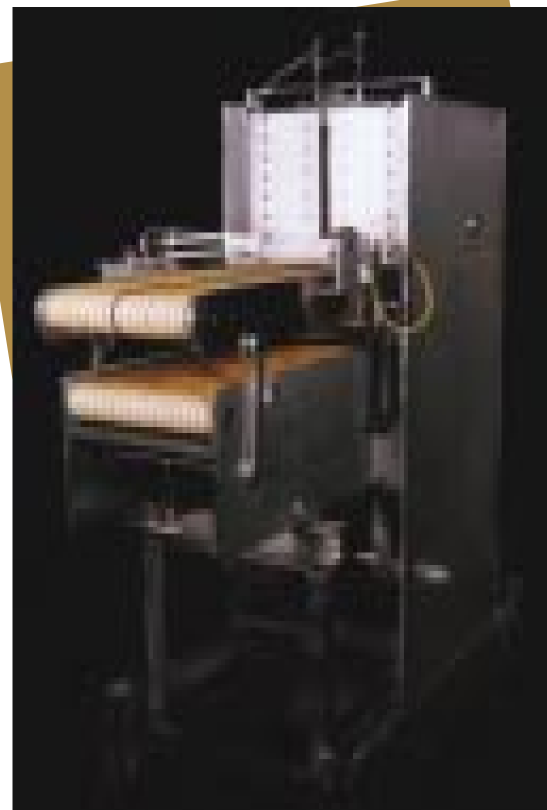
Left -- Unzen's path of destruction leads through agricultural and urban areas to the sea. The volcano produced about 10,000 flows in four years.

Agencies involved in the drilling include the Science Technology Association of Japan, the International Continental Drilling Program, and the U.S. National Science Foundation.

In 1984, Eichelberger led a similar research expedition that drilled into the dormant Obsidian Dome Volcano, near Mammoth Lakes in California. The results from that project led to the development of a new theory about lava eruptions. Eichelberger expects the work at Unzen Volcano to provide results even more useful.

Knowing more about a volcano's plumbing will help scientists issue proper warnings when a volcano shows signs of unrest. Following the work at Unzen Volcano, researchers at the Alaska Volcano Observatory may be able to tell whether volcanoes in Alaska will awake with a bang or with a steady gurgle of lava.

GI Machinists Develop Fish-Bone Removal Machine



PHOTOS BY JEFF PEDERSON
DIGITALLY ENHANCED BY DEB COCCIA

When agencies in Alaska need precision machine work done, they often ask for help from the Geophysical Institute machine shop. Though the main task of shop supervisor Larry Kozycki is to serve institute researchers, he and the four machinists who work for him often work on projects for other organizations.

To help fund operation of the shop, Kozycki also initiates independent projects, such as the design and development of new products. A recent example is the invention of two machines that remove nuisance pin bones from salmon filets.

Pin bones are tiny bones that extend from the backbones of salmon and remain in fish after the fillet process, forcing seafood processors to remove them by hand or with the assistance of a hand-held mechanical device. If workers could remove pin bones automatically, fish processors would be able to better use species that are less valued, such as pink and chum salmon.

In 1997, Kozycki saw an opportunity to develop an automatic pin-bone removal machine and acquired funding from the Alaska Science and Technology Foundation to begin work. Three years, three funding sources, and six versions of the machine later, he and others in his shop have created two working prototypes. One of the pin-bone removal devices, designed for grocery stores, independent fishermen and other small-volume processors, fits on a tabletop. The other version, which is as large as a refrigerator, is for high-volume users, such as fish canneries.

Machinist Ned Manning devoted about 20 hours each week to the project for three years. Upstairs in the machine shop, he pointed to a 12-foot-by-12-foot graveyard of hoses, metal housings and gears.

"We've worked on at least six models, and on each of those we did four or five modifications until we scrapped it," Manning said while standing near a pile of parts as high as his waist.

On his computer, Kozycki designed all of those gears, camrollers, shafts, and discs, many of which appeared in more than one version of the machine.

"I've got drawing files that look like the Manhattan phone book," he said.

For a shop that solves most of its problems quickly with talented machinists and precision tools found nowhere else in the state, the fish-bone-removing machine presented a unique challenge. Part of the difficulty arose from working with salmon flesh.

A machinist can manipulate almost any material—steel, plastic, rubber—to create something useful, but salmon has less consistent properties. Fresh fillets have a firmer texture than fillets that have been frozen, and texture varies by species and size of fish. Some of the fillets the shop received via air from Kodiak were firm and easy to work with.

"Others had the consistency of peanut butter with bones in it," Kozycki said.

Manning and other machine shop employees, including his brother Tim Manning, Dale Pomraning, and Jeff Nelson, worked on version after version of the machine.

"There were some days you just had to walk away from it," Ned Manning said.

Manning persevered, developing a small model of the machine that he took to a wholesale seafood supplier in the Seattle area in July 2000.

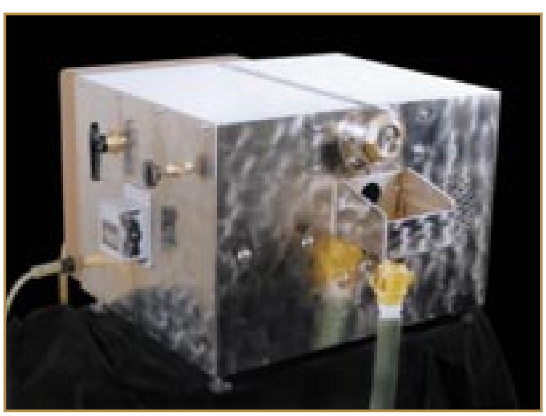
It performed well on fish with small-to-medium size bones, but needed to be modified for larger fish. Still, fishermen and small-scale processors who often spend their winters de-boning fish by hand wanted one of their own after seeing Manning's presentation.

"If we would have had a dozen of them, we could have sold them then," Kozycki said.

Manning escorted the larger version of the machine to Kodiak Island in August 2000. There, he sent thousands of pink salmon fillets through the machine.

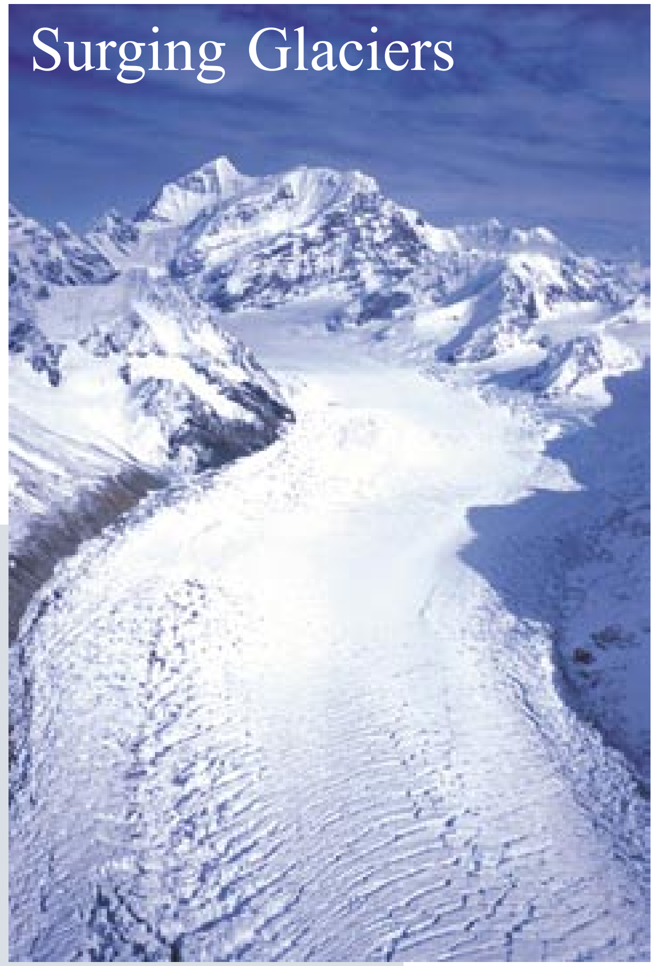
The machine's onboard computer had problems and Manning had to make several mechanical adjustments, but the machine removed about 90 percent of the bones. Shop personnel made the needed modifications to the machine when Manning returned.

Kozycki's goal is to entice another company to manufacture the machines, while the machine shop and the University of Alaska would receive licensing fees for developing them.



The Geophysical Institute Machine Shop has produced a large (above right) and small (lower left) model of a machine that removes problem bones from salmon.

Black Rapids and Yanert: Two Surging Glaciers



PHOTOS COURTESY OF KEITH ECHELMEYER.

Glaciers that mysteriously surge after decades of relative inactivity have been famous in Alaska since 1937, when the following report on the movement of Black Rapids Glacier appeared in Time magazine.

"Out of Central Alaska last week came an exciting story. The Black Rapids Glacier, long dying in its valley 125 miles south of Fairbanks, had come to life. Its mile-and-a-quarter face was shoving toward the Delta River and the Richardson Highway (sole motor road from Fairbanks to the coast), rearing ice crests to 500 feet, breaking off great land icebergs which tumbled thunderously ahead onto the mossy valley floor. Geologist Ernest N. Patty at Fairbanks declared this week that if the Black Rapids Glacier is moving as reported, it is traveling 220 feet per day, a world record."

Geophysical Institute glaciologists recently noticed another Alaska Range glacier undergoing the same process. Yanert Glacier began surging in the spring of 2000, again raising the question of why some glaciers surge and others do not.

Of thousands of glaciers in Alaska, less than 100 follow the pattern of Black Rapids and Yanert—suddenly advancing great distances after remaining almost motionless for decades.

Black Rapids has not surged since it threatened the Richardson Highway in 1937, but history suggests that it will repeat the process someday.

Surging glaciers seem to follow cycles of rapid advance followed by a "quiescent" phase, a time when glaciers like Black Rapids retreat and gain weight in the form of snow or ice in their upper regions. Before the spring of 2000, Yanert Glacier last surged in 1942.

Surging glaciers all share the same pattern — the accumulation of vast amounts of ice and snow high in the mountains followed by the sudden downslope movement of frozen material, often at rates even more impressive than Black Rapids' historic 220 feet per day reported in 1937.

After one or two years of rapid advances, surging glaciers stop dead within one or two days, usually in mid-summer. The glaciers then creep along for decades, until ice and snow recharge the higher sections. Later, at a certain breaking point, the glaciers surge again, often in winter.

In the summer of 1997, Geophysical Institute glaciologists Will Harrison, Martin Truffer, Keith Echelmeyer, and Roman Motyka used hot-water drills to penetrate Black Rapids Glacier. Six hundred meters below the surface, they found a layer of glacial till—rocks mixed with silt—that may be one of the mechanisms responsible for a surge. When mixed with water, this layer of glacial till, which is about 5 to 10 meters thick, turns into mud that acts like a lubricant.

Recent photos of the Yanert Glacier show the cracks that are characteristic of a surge.

In the summer of 2002, the researchers will return to the glacier with new instruments designed by Kevin Abnett, of the Geophysical Institute electronics shop, and Dale Pomraning, of the machine shop. Pomraning is creating a device that can be used to pound instruments into glacial till, 600 meters below the surface of Black Rapids. Abnett is inventing a communications system that will allow glaciologists to monitor movements within the till and to measure the pressure of sub-glacial water, which may help researchers determine the flotation of a glacier.

Scientists theorize that the incredibly heavy ice in the upper levels of the glacier presses down on the till, creating pinch points behind which water ponds up beneath the glacier. This water may build up enough to float the glacier and make it slide on the muddy till. The abrupt end to a surge may occur because a dam at the pinch-point breaks. The dam then releases water and the glacier stops surging.

The flood of water glaciologists have seen released from beneath surging glaciers is rich in sediment—a surging glacier erodes as much rock and soil in a few years as it did in the 50 or 60 years of its quiescent phase.

An Overlooked Mode of Sediment Transport

During a naval expedition to the Arctic in the 1820s, Russian explorer Baron Ferdinand Petrovich von Wrangell penned on a map the strange presence of dirt trapped in sea ice.

During an icebreaker expedition through the drift ice of the Arctic Ocean in 1991, Associate Professor of Geophysics and Sea Ice Hajo Eicken noticed the same phenomena.

"It's striking to see," Eicken said. "When crossing 1,500 kilometers of ice, you see this sediment all over the place."

Eicken and Graduate Research Assistant Aaron Stierle are studying sediments in sea ice at a natural laboratory—Elson Lagoon near Barrow.

Eicken said only wind can move sediment over long distances faster than sea ice. This overlooked mode of sediment transport could be one of the ways pollutants migrate from one area to another.

PHOTO COURTESY OF HAJO EICKEN

Clusters of sediment in an ice slab and the dirty ice surface beyond it are shown in this photo of sediment-laden sea ice from the Laptev Sea (Siberiean Arctic).

Eicken and Stierle conduct their research by studying sediments cored from sea ice in the lagoon. They also use buoy observations of ice movement, remote sensing data revealing ice growth, and computer models.

Eicken recently collaborated with Russian colleagues from the Arctic and Antarctic Research Institute in St. Petersburg to study 20 million tons of sediment from the northern Siberia coast trapped in a 200,000-square-kilometer field of sea ice (an area about half the size of Alaska).

The sea ice, drifting like jigsaw puzzle pieces over the pole with wind currents, carried the sediment to the Greenland Sea, thousands of kilometers away. There, the sea ice released the particulates as it melted, raining sediment over the ocean floor.

Studying sediments trapped within the ice also could help researchers predict the fate of dirty sea ice, which melts at a faster rate than sea ice without trapped sediments.

Sediment research also may shed light on when the Arctic Ocean developed a cover of ice.

"If we know how this process works today, we can find out a lot about the evolution of the arctic ice cover," Eicken said.

The *Geophysical Institute Quarterly* is published as a public service by the University of Alaska Fairbanks Geophysical Institute Information Office: **Kathryn Bertram**, editor, writer; **Deborah Coccia**, graphic artist; **Ned Rozell**, writer; **Lynda McGilvary**, editorial assistant. Free subscriptions are available by e-mail at fygipub@aurora.alaska.edu, by phone at (907) 474-7558; by fax at (907) 474-7290, from the address above, or on-line at http://www.gi.alaska.edu. UAF provides equal education and employment opportunities for all, pursuant to applicable state and federal laws.

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