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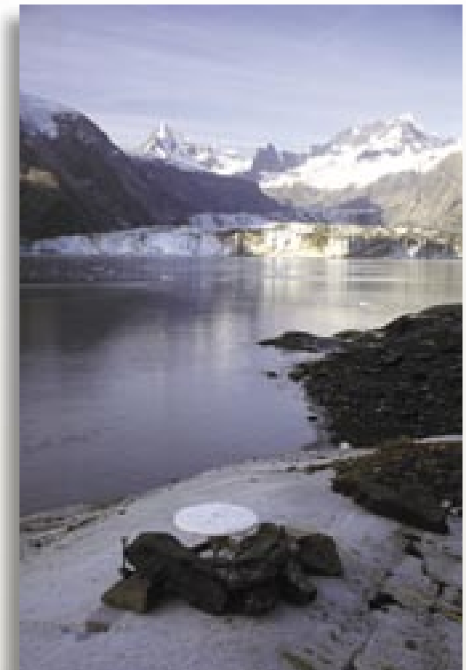
Southeast Alaska on the Rise

New ground motion measurements show that Southeast Alaska is one of the fastest-rising regions on Earth. Two areas on the Alaska panhandle—Glacier Bay and the Yakutat ice field (a group of glaciers in the Saint Elias Mountains southeast of Yakutat)—are rising at a rate of about 30 millimeters per year. By comparison, the world's largest mountains in Nepal and Tibet are rising about 5 millimeters each year.

To document the rise, Geophysical Institute Associate Professor Roman Motyka, Post-Doctoral Fellow Chris Larsen, and Research Technicians Adam Bucki and Sandra Zirnheld visited 80 survey points in Southeast Alaska in summer 2003.

Traveling by 27-foot boat, inflatable raft, and float-equipped aircraft, the team set up Global Positioning System (GPS) receivers at previously measured sites from north of Yakutat to south of Juneau, including Glacier Bay and the Inside Passage.

By comparing GPS data and geologic surface evidence against computer models, the researchers found that the rapid uplift in Southeast Alaska appears to be due to isostatic rebound, the viscoelastic reaction of Earth's crust to the removal of staggering amounts of glacier ice. Isostatic rebound is evident at Glacier Bay, where an ice sheet documented in 1794 as being 6,000 square kilometers in area and up to 1.5 kilometers thick has since receded 96 kilometers, lifting weight off the surface beneath. As a result, land in the area has risen more than 5.5 meters.



Although large volumes of ice have been lost in Southeast Alaska in the recent past, separating the amount of uplift caused by glacial rebound from that caused by tectonic forces is a challenge.

The Queen Charlotte-Fairweather fault system, which is larger than the San Andreas fault system, cuts through the heart of the research area. It is responsible for creating the Fairweather Range, one of the great coastal mountain ranges of the world. However, when researchers compared new data from the 80 GPS sites with previous measurements at the same locations, the fault was revealed to be moving purely in a strike-slip direction.

Researchers say the strike-slip fault cuts too cleanly through the study region for tectonic motion to be the primary driving force behind uplift in the area, and that isostatic rebound is likely responsible for the land's rapid rise in elevation.

PHOTOS BY CHRIS LARSEN

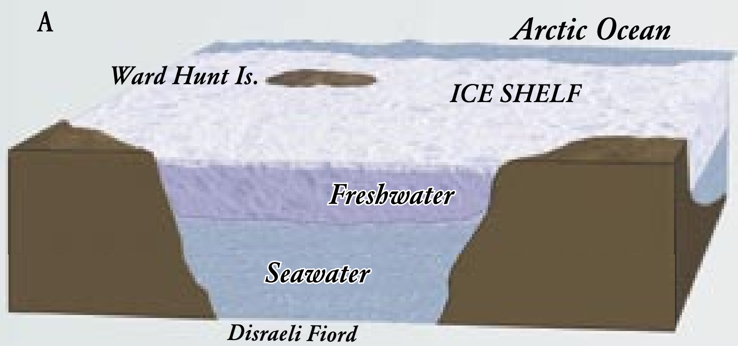
Global Positioning System Receiver—*Geophysical Institute Research Technicians Adam Bucki and Sandra Zirnheld set up a GPS receiver in Tarr Inlet within Glacier Bay (right). Margerie Glacier and Grand Pacific Glacier are visible in the background.*

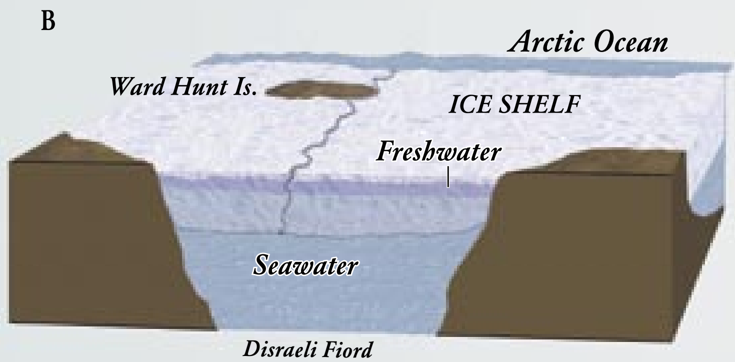
Benchmark—*A Global Positioning System receiver rests on a bedrock benchmark in Glacier Bay's John Hopkins Inlet (middle).*

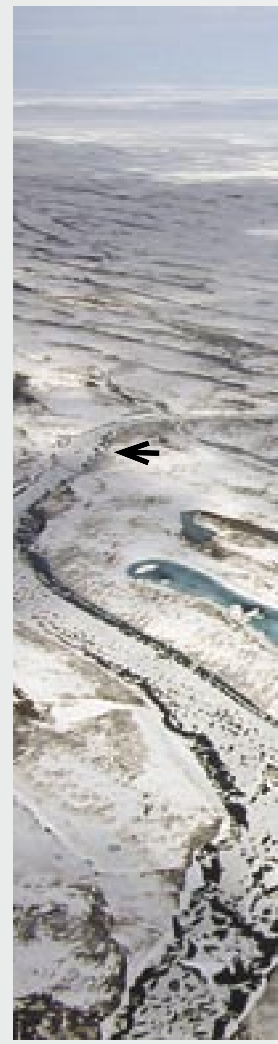
UNIVERSITY OF ALASKA FAIRBANKS

Giant Arctic Ice Shelf Cracks Up

ILLUSTRATIONS BY DEBORAH COCCIA MANNING







A several-thousand-year-old ice mass larger than the city of Chicago fractured off the northern coast of Canada in August 2002. At the Geophysical Institute, a professor working with colleagues in Canada helped detect the change.

Geophysical Institute Research Professor Martin Jeffries was one of the first scientists to notice that the Ward Hunt Ice Shelf, the largest of its kind in the Arctic, had broken in two and developed other cracks during the past three years. Through analysis of satellite images received at the Alaska Satellite Facility (ASF), he confirmed what Derek Mueller and Warwick Vincent of the Center for Northern Studies, Laval University, Québec, had seen in the field.

Jeffries authored a paper on the ice shelf with Mueller and Vincent, "Rapid Break-up of the Largest Arctic Ice Shelf and Associated Loss of a Polar Ecosystem," which drew worldwide attention after it was published in Geophysical Research Letters in October 2003.

In the paper, they wrote that Mueller flew over the ice shelf during the summer of 2002. He saw a large fracture running from north to south, "cleaving the ice shelf in two and destroying its overall integrity."

ASF received raw data and processed images of the ice shelf from RADARSAT-1, an Earth-observing satellite owned by the Canadian Space Agency. The crack was evident on images of the ice shelf from as early as 2000.

"This is the first time we have actually witnessed in near real-time–through people on the ice and by satellite–the appearance of fractures in the ice and the catastrophic drainage of an epishelf lake," Jeffries said.

Until the recent fracture, the ice shelf served as a dam that held a freshwater "epishelf lake" in the 30-kilometer long Disraeli Fiord. In June 1999, Vincent's measurements revealed that the lake was about 27 meters deep. When Mueller measured it again in July 2002, it had decreased to about three meters deep. The decrease in the fresh and brackish water caused the disappearance of many unique organisms that scientists studied as possible analogues of life on other planets.

Disraeli Fiord now has a direct surface connection to the ocean for the first time in thousands of years. Before the fracture appeared, researchers found ancient driftwood, probably from the Mackenzie River and Eurasia, stranded on the shores of the fiord. None of the wood samples were less than 3,000 years old, suggesting that the Ward Hunt Ice Shelf sealed the fiord off from the Arctic Ocean at least that long ago.

The Ward Hunt Ice Shelf was a small part of a giant ice shelf on the north rim of Ellesmere Island during Robert Peary's explorations in 1909. By 1982, only 10 percent of the former Ellesmere Ice Shelf remained. During the past 20 years, the Ward Hunt Ice Shelf has been relatively stable. Other factors may be involved, but scientists suspect that a warmer climate contributed to the recent breakup.

A temperature increase of about one-half of a degree Celsius has been recorded each decade since 1967 at Alert, a small outpost on Ellesmere Island near the ice shelf.

"It's the largest Ellesmere Ice Shelf change in 40 years and it comes precisely at a time when many other parts of the cryosphere in the Arctic also are changing," Jeffries said. "The breakup could be additional evidence for arctic environmental change."

PHOTO BY DEREK MUELLER

Freshwater–*At far left, in Figure (A), the epishelf freshwater lake of Disraeli Fiord is shown dammed behind the Ward Hunt Ice Shelf. Figure (B) depicts draining at the surface via the fissure now separating the two halves of the ice shelf.*

Cracks–*Arrows on the adjacent photo and the inset RADARSAT fine beam image point to the largest of many cracks now covering the Ward Hunt Ice Shelf.*

RADARSAT FINE BEAM IMAGE

Two Views–*The photo of Ward Hunt Ice Shelf was taken on July 28, 2002. The RADARSAT fine beam image was captured on August 30, 2002.*

PERSONAL EXPERIENCE: Geophysical Institute Research Professor Martin Jeffries knows the Arctic's largest ice shelf better than most. He has camped for weeks on the 443-square-kilometer mass of ice, which is frozen onto the northern shore of Ellesmere Island. In the 1980s, Jeffries earned his doctoral degree while studying the formation of the Ward Hunt Ice Shelf, a source of icebergs that could endanger oil platforms in the Arctic Ocean. In August 2002, the northern edge of the ice shelf broke off into the ocean, releasing five square kilometers of moving ice islands.

Fall 2003 Active Time for Aurora Forecasters

Photo taken by Ulrich Rieth in Mainz, Germany, on October 30, 2003

Two large solar flares and a huge geomagnetic storm treated the world to aurora displays at low latitudes in the fall of 2003. The events prompted retired Geophysical Institute Professor Charles Deehr and Research Professor Dirk Lummerzheim to predict maximum auroral activity for two nights in late October and three nights in November.

The researchers' Web site (http://www.gi.alaska.edu/cgi-bin/predict.cgi) received more than 600,000 log-ons in October from aurora viewers as far south as Madrid, Spain.

In late October, the first of the two flares knocked out the ADEOS-2 satellite, used since its launch 10 months earlier by researchers to collect data on global warming and other climate phenomena. The Japanese government announced the loss of the $640 million observation satellite shortly after the giant flare sent a shock front ripping toward Earth at 2,500 kilometers per second.

Astronomers have an alphabetical scale for solar flares: C-class flares are normal; Ms are large enough to produce active auroral displays; and Xs are extreme. The flare on October 28th was an X-17, the third-largest recorded solar flare since the mid 1970s, when satellites gained the capability to measure them.

"Usually we get excited when we see an M," Lummerzheim said.

A few days later, a solar flare rated an X-28 erupted from the same sunspot. It was the largest ever recorded in the satellite era.

A large geomagnetic storm occurred when the same active region of the sun appeared one solar rotation later on November 20th. The result of a coronal mass ejection toward Earth, the storm was the second largest ever recorded. The largest storm, which occurred in March 1989, caused a power outage throughout Québec, Canada.

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