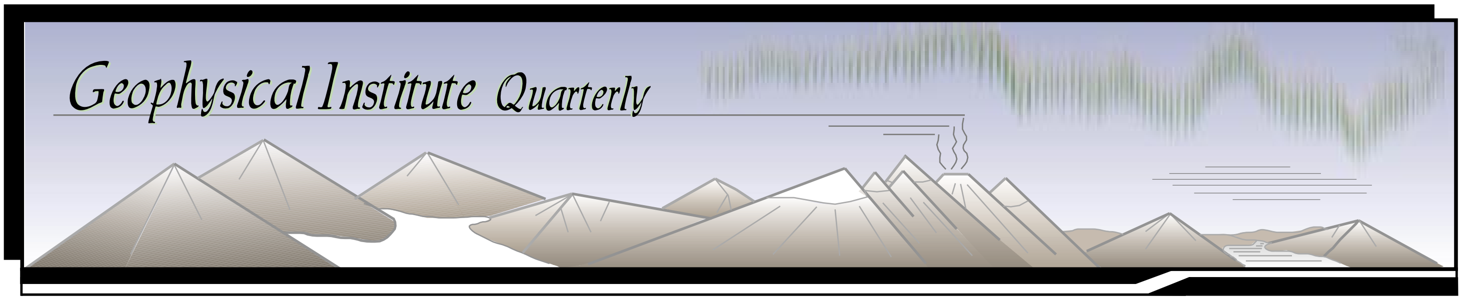

Geophysical Institute Quarterly

Volume 17: No. 4, 2002

A Detailed Look at One of the World's Great Glaciers

Bagley Ice Valley, averaging 10 kilometers wide and extending for 100 kilometers in Alaska's St. Elias and Chugach mountains, is the main source of ice feeding the massive Bering Glacier. Together, the Bering Glacier-Bagley Ice Valley system is the largest glacier and icefield complex in continental North America.

To provide a baseline for future losses and gains in the massive icefield complex, and to detect changes that occurred from the past to the present, GI scientists are using a new digital elevation model (DEM).

Research using the new model began in late August 2000, when Professor of Geophysics Keith Echelmeyer flew in his Super Cub, fitted with laser-measuring equipment, over the Bagley Ice Valley to record elevation data along the central flow line of the ice.

Two weeks later, in September 2000, Intermap Technologies Corporation flew a detailed survey using their Learjet-mounted Star-3i synthetic aperture radar (SAR) system. Technicians later used the data acquired during these flights to create a series of high-resolution DEMs.

NASA's Scientific Data Purchase Program funded data acquisition through a grant to Research Professor of Geophysics Craig Lingle.

Validation of the vertical accuracy of the new high-resolution DEM was performed by Reginald Muskett, a Ph.D graduate research assistant at the GI. The validation comparison showed that the new model has an average vertical accuracy of about 1 meter on Bagley Ice Valley.

To determine how the ice valley has changed, Muskett is comparing the new Bagley Ice Valley model with old DEMs created by the U.S. Geological Survey about 30 years ago.

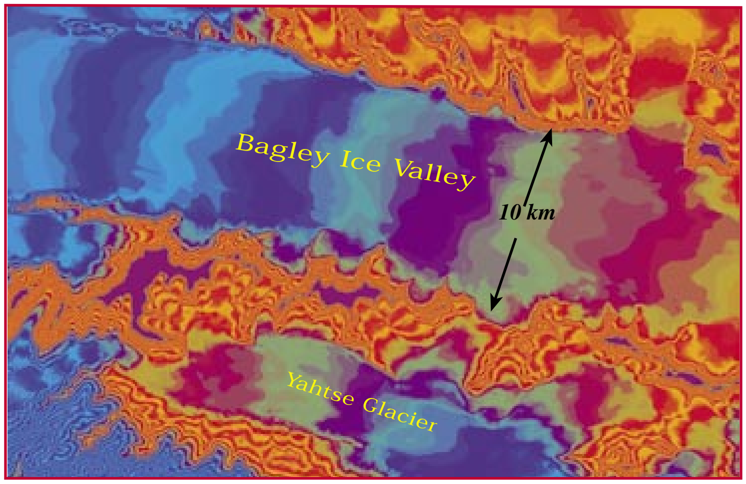
These old USGS models are based on air photos taken over the ice valley in 1972 and 1973, and topographic maps available at that time.

The differences among current measurements and those obtained in the early 1970s are striking, but quantifying the accuracy of the changes between old and new DEMs is challenging.

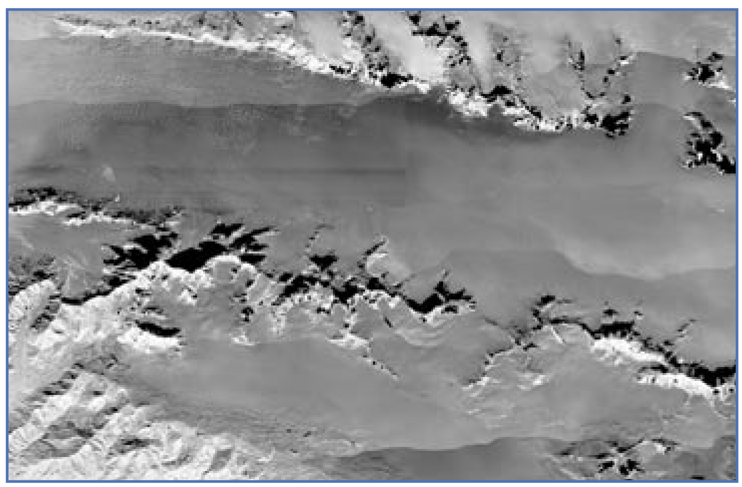
Much of the difficulty lies in the fact that the old DEMs often contain errors resulting from efforts to map low-contrast icefields using stereo air photos from the 1970s. These errors can lead to misconceptions.

For example, despite an overall thickening of the entire Bagley Ice Valley, Quintino Sella Glacier, a major tributary, shows a drastic loss in elevation from the 1970s to the present. Does this loss indicate a surge since the 1970s, or an error in mapping?

Despite these difficulties, the changes in the icefield over the past 30 years have been large enough to enable Muskett to estimate a substantial volume gain for this area. Muskett's finding of volume gain is in sharp contrast to the volume losses that Alaska glaciers have experienced at lower elevations.



The DEM of Bagley Ice Valley at left shows terrain elevations of the largest glacier and icefield complex in continental North America. Intermap Technologies Corporation developed the DEM using In-SAR technology. The entire DEM, only a third of which is shown here, covers 3,000 square kilometers.



Intermap Technologies Corporation used a Learjet-mounted Star-3i SAR system to acquire data for the gray-scale image at right, which covers the portion of Bagley Ice Valley shown above. The seamless DEM was created using 27 SAR image files at 1:24,000 scale. The IARC-NASDA In-formation System processed the data.

Mt. Cleveland Eruption Observed with Variety of Tools

The 2001 Mt. Cleveland eruption in the Aleutian Islands produced an ash cloud that evolved into a 1,000 kilometer arc, one of the longest recorded in the North Pacific region. The size and resilience of the ash cloud allowed GI and Alaska Volcano Observatory (AVO) researchers to use and validate an unprecedented variety of eruption detection and tracking tools.

Mt. Cleveland, located about 1,500 kilometers southwest of Anchorage in the volcanic Aleutian chain, erupted in February and March 2001. After tracking the eruption using several satellite-detection systems, GI and AVO researchers were able to warn the aviation community. On three occasions, the volcano erupted ash as high as 12 kilometers into the atmosphere, forcing the Federal Aviation Administration to route aircraft south and west of Mt. Cleveland.

GI Research Associate Professor Ken Dean currently leads a team of scientists and students in analyzing the 2001 eruption. The team is tasked with comparing the variety of satellite-monitoring options available to volcanologists.

NOAA's Advanced High Resolution Radiometer (AVHRR) sensor recorded the first images of Mt. Cleveland's ash plume within a few hours after the first eruption.

Continuing coverage by NOAA's Geostationary Observation Environmental Satellite (GOES) provided three days of time-sequential imagery of the plume as it moved across northwest Alaska. AVO scientists used data from both sources to determine the temperature of the ash plume and estimate its altitude.

Data revealed that the eruption was trapped in an atmospheric deformation zone that pushed the ash cloud in a wide arc over mainland Alaska. The GOES satellite data showed the evolution of the ash cloud as it extended 1,000 kilometers from Russia to Kodiak. The eruption helped GI scientists show the utility of GOES satellite data for tracking airborne ash at high latitudes.

A volcanic ash dispersal model known as PUFF, developed at the GI, predicted the movement of the eruption cloud. These predictions and observations also were relayed to aviation authorities. In addition, the ash cloud was detected with the new Moderate Resolution Imaging Spectrometer (MODIS), and by Landsat 7 sensors.

"The detection of the eruption cloud was amazingly similar on MODIS, AVHRR, and GOES data, despite the differences in spectral resolution and viewing geometry," Dean said.

Volcanologists also received information from aircraft pilots who described seeing the ash cloud or smelling sulfur.

"The eruption marked the first time a volcanic cloud predicted by dispersion models was detected beyond the plume observed on satellite data," Dean said. "A pilot in San Francisco reported smelling sulfur associated with it."

PHOTO BY D. CULLY

Mt. Cleveland--Snow-covered Mt. Cleveland is pictured above on February 2, 2001. Steam at the summit is emitting from the hot deposit shown on the flank of the volcano.

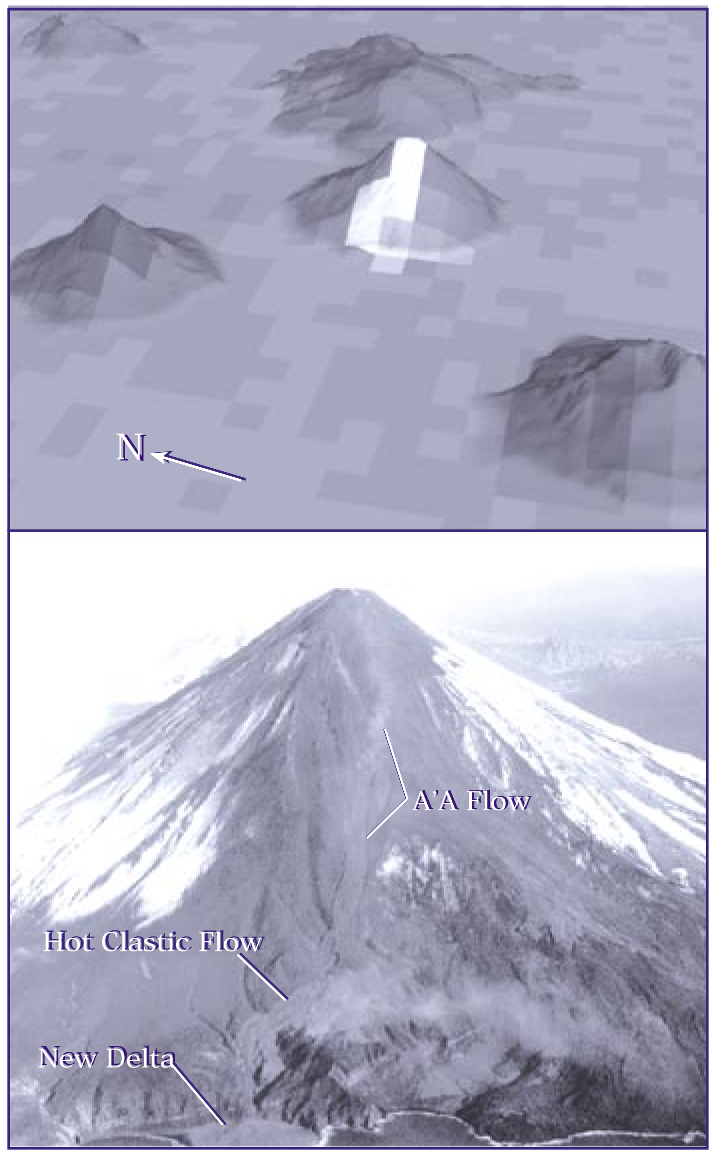
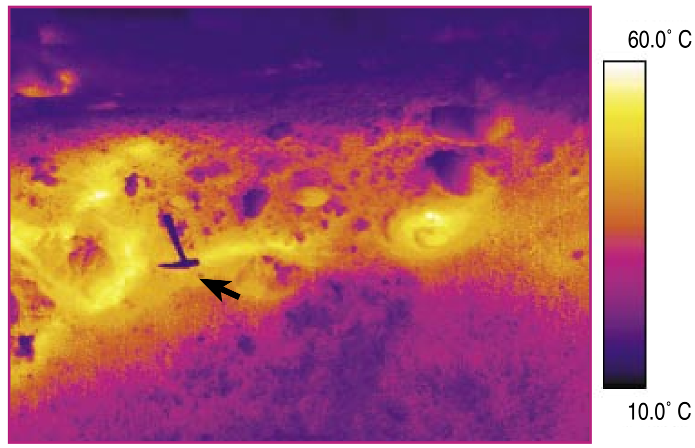


PHOTO BY B. MEES

AVHRR Data—A thermal anomaly in AVHRR data on February 22 (top right) is draped over a digital elevation model. Each pixel is approximately 1 x 1 km. The hot ground extends from the summit to the ocean. The aerial photograph (bottom right), taken on February 21, shows that the source of the hot ground is a lava flow of a 'a and hot clastic material in a narrow channel ending at a newly formed delta. Steam can be seen emitting from the flow.

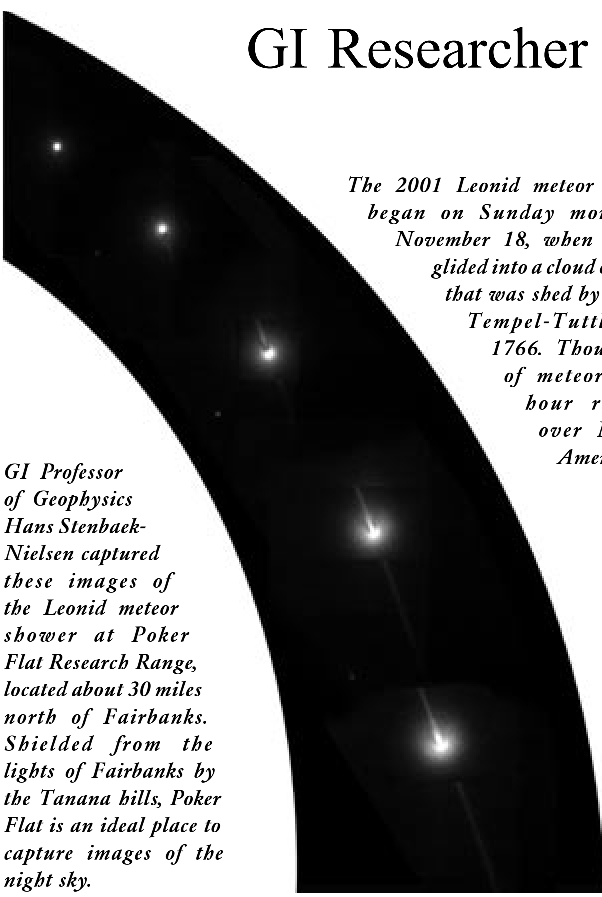
PHOTO BY JON DEHN



SAR Image—The composite SAR image of Mt. Cleveland, above, was generated using multitemporal Radarsat data before and after the February 2001 eruption. The data was received by the Alaska SAR Facility located in the GI.

Hot Debris Fan—The hot debris fan on the new western shore of Mt. Cleveland volcano is shown at right in contrasting multicolored infrared and black-and-white photos. The hammer, shown in both photos, was placed to show scale and orientation. The fan, which reached temperatures of 100 degrees Fahrenheit, may represent a new type of volcanic flow for snow-covered stratocones.

GI Researcher Captures Leonid Shower in Detail



The 2001 Leonid meteor storm began on Sunday morning, November 18, when Earth glided into a cloud of dust that was shed by comet Tempel-Tuttle in 1766. Thousands of meteors per hour rained over North America.

GI Professor of Geophysics Hans Stenbaek-Nielsen captured these images of the Leonid meteor shower at Poker Flat Research Range, located about 30 miles north of Fairbanks. Shielded from the lights of Fairbanks by the Tanana hills, Poker Flat is an ideal place to capture images of the night sky.

A high-speed camera developed by GI Professor of Geophysics Hans Stenbaek-Nielsen captured images of the November 18, 2001, Leonid meteor shower at 1,000 frames per second. The images show for the first time how a shock-like wave forms in front of a meteor and then expands into a ball of hot gas as the meteor blazes into Earth's atmosphere.

Stenbaek-Nielsen unveiled the images during the fall 2001 meeting of the American Geophysical Union in San Francisco. He captured the images at Poker Flat Research Range as Earth moved through a debris stream from comet Tempel-Tuttle, which orbits the sun.

Stenbaek-Nielsen's colleagues were impressed by the sequence of photos. As reported by journalist Robert Orion on Science Magazine's web site: "The new images 'make a significant contribution to our understanding of basic meteoroid phenomena,' said aerospace engineer Iain Boyd of the University of Michigan, Ann Arbor. In particular, Boyd notes, the shape and surprisingly large size of the bow shock suggest that particles in the upper atmosphere strip molecules from the meteoroid and quickly form a cloud of hot vapor around it, creating the glow witnessed from the ground."

GI Project Engineer Jim Desrochers and GI Professor Emeritus Tom Hallinan assisted in the creation and testing of the camera, and the late GI Machine Shop Supervisor Larry Kozycki designed and manufactured the instrument's shell.

Southeast Alaska on the Rise

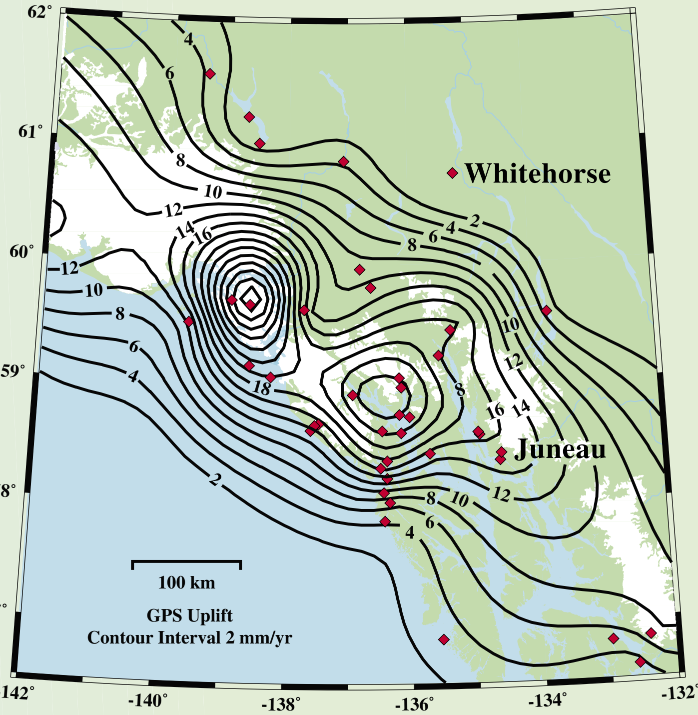
Southeast Alaska may be one of the fastest-rising regions on Earth. Uplift velocities of more than 3.6 centimeters annually in Southeast Alaska—the highest measured rate of uplift in the world—have been obtained using GPS receivers and dendrochronology by GI Research Associate Professor Roman Motyka, Associate Professor of Geophysics Jeff Freymueller, and Professor of Geophysics Keith Echelmeyer.

The researchers measured the most rapid uplift east of Yakutat, but other areas in Southeast Alaska have risen at close to the same rate. Sullivan Island, between Juneau and Haines, has risen more than 5.4 meters in the last 250 years.

The loss of ice in Glacier Bay and other nearby areas may be the reason northern Southeast Alaska is on the rise. When the land bounces back after lying under the oppressive weight of glacier ice for centuries, scientists call it "post-glacial rebound."

But post-glacial rebound isn't the only force at work in the area. The movement of plates in the nearby Fairweather Fault, where two of Earth's vast plates—the Pacific and North American—grind past one another, could be compressing the crust and forcing it upward in places.

The GI team will continue to map the uplift pattern by collecting current data to add to the more than 80 precision GPS benchmarks established across the region.



Uplift rates have been measured at sites shown in red across Southeast Alaska.

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 info@gi.alaska.edu, by phone at (907) 474-7558; by fax at (907) 474-7125, 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.

GEOPHYSICAL INSTITUTE
University of Alaska Fairbanks
903 Koyukuk Drive
P.O. Box 757320
Fairbanks, AK 99775-7320

Address Service Requested