



The Geophysical Institute QUARTERLY

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New Equipment for Research

The location of the Geophysical Institute is such that our arctic and subarctic environment provides a unique opportunity for experimental research on polar physical phenomena. In other parts of the world researchers more often deal with theoretical aspects of polar geophysics, because for them data acquisition in the Arctic not only requires proper equipment but expensive expeditionary activities as well.

Experimental research, wherever conducted, must be done using suitable equipment. As we acquire new knowledge about Alaska and the polar regions, the problems that we seek to explain change and, as a result, we need new types of equipment to measure and understand new phenomena.

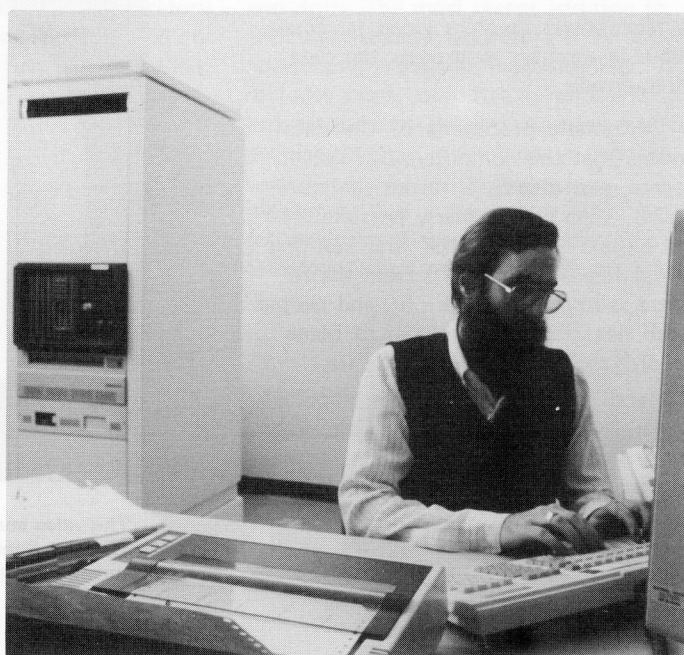
The rapid change in technology contributes to frequent opportunities for improved observation, but it also makes the maintenance and repair of relatively young items of equipment very expensive and sometimes impossible. Equipment becomes obsolete with increasing speed. Sometimes perfectly useful equipment which is only a few years old is no longer compatible with newer equipment and no longer repairable because the manufacturers stop making parts.

Technology has been changing so fast that over the past ten years the average stock of equipment for data acquisition and analysis at the Institute has deteriorated in condition and declined in usefulness. We have developed an increasingly large supply of irreparable machinery which we keep only to provide a source of parts for like models. If other institutions, private firms, and government agencies acquire the latest research equipment and we do not, our graduate instruction program will fail to prepare our students properly. Also, if we are still dependent upon human analytical processes rather than on modern instrument and computer analytical techniques, the cost of personal services will increase and we will become less competitive in our bid for federal research support.

We are thus very pleased to tell you on the following pages about some major additions to our equipment which will im-

prove our ability to solve research problems facing Alaska. Several of our acquisitions are described in detail and their usefulness illustrated.

Merritt Helfferich
Assistant Director for Administration



Cole Sonafrank works with the new MASSCOMP seismology laboratory computer. This system will greatly enhance the ability to analyze seismic activity, thus improving public safety (see page 2). J. Coccia photo.

Improved Scientific Tools

MASSCOMP

The Geophysical Institute has acquired a new computerized system that receives and analyzes seismological data (see photo on page 1). This recently installed equipment will allow Drs. Davies, Biswas, and Pulpan to deal economically and efficiently with vast amounts of data from many remote seismic stations throughout Alaska. The research effort will be concentrated on the central interior and southcentral regions, including Cook Inlet, the Alaska Peninsula, and Kodiak Island.

This new system is based around two Masscomp computers, with numerous accessories. Some features are:

- Data arriving at the laboratory are sampled 120 times each second and are digitized—assigned a numerical value—immediately. Once the information is in numerical form, the computer can automatically and swiftly process it, filtering out “noise” (from wind, for example). The entire seismic wave for each station can be saved, since we don’t have the recording problems of film or paper records such as overlapping of adjacent traces. Perhaps best of all, the record now can retain the smallest detectable tremor without losing the high peaks and low valleys of a big earthquake.
- High-power graphics video terminals allow researchers to process the data interactively.
- Automatic processing of the data means that the computers can detect, locate, and display an event far more swiftly than was formerly possible. The computer “knows” what the “nothing happening here” signal is from the remote seismographic stations, and people need not scan hours’ worth of blank records to find the significant data.

Because the new system can graphically display information on earthquakes and volcanic eruptions minutes after their occurrence, it allows us to detect and evaluate dangerous seismic events more accurately than ever before.

New Computers in Aeronomy

Researchers in the aeronomy group at the Geophysical Institute have acquired several new small computers that are enhancing many aspects of their studies. Personal computers have become sufficiently fast to handle data at the high rate required for making images and, especially important, they are now small enough to take into the field. After considerable study, the aeronomists decided that the Compaq 386 would be an appropriate computer.

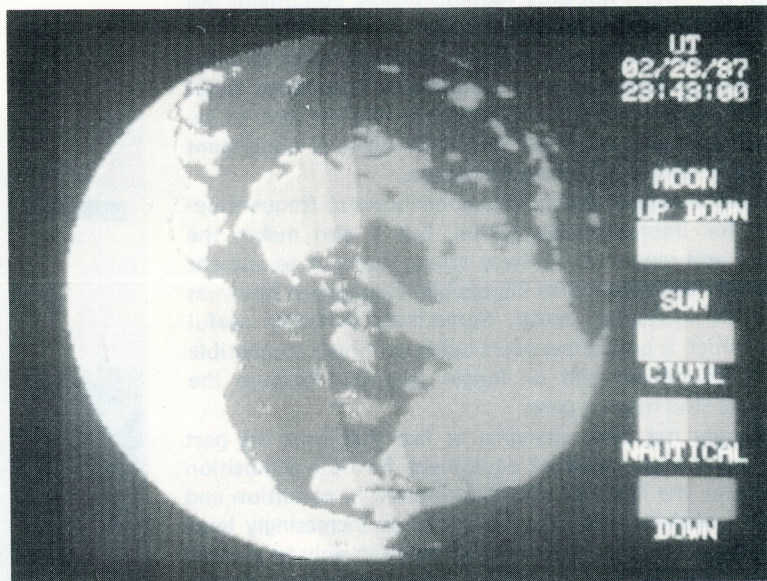
Programmer Jim Baldrige has developed unique software for the computers. This software can produce a barium release image that has been acquired by an “imaging photon detector.” The system was first used by Professors Hans Nielsen and Roger Smith to study a barium release from two rockets launched in Sondrestrom, Greenland, in 1986. For this study, the barium was released from the rockets at an altitude of 500 kilometers. As the barium vapor ionized in light from the sun, it made visible traces along the earth’s magnetic field lines. The light

from those traces was recorded, and images were viewed immediately on a video display with use of the computer system. Observations of the barium releases were made from Greenland, Svalbard, and the Canary Islands.

Professor Tom Hallinan has been able to make use of the television image capture boards in his Compaq 386 computer to digitize a single frame of a video tape of an aurora. He can then determine the relative brightness of different parts of the aurora using “post hoc photometry.”

Bob Erickson, who works for Professor Chuck Deehr, has been using the computer to predict the location of the auroral oval and the day-night boundary (terminator) on the globe at various dates and times. He can produce a many-colored image this way.

At last count, there were six of these computers in use, with more on order. These powerful little machines have already produced some exciting results; we expect more to come.



This video image of the globe was produced for the time of the 1987 barium release in Sondrestrom, Greenland. Both the sun and the moon are down at the three observation sites, Svalbard, Greenland, and the Canary Islands.

Tiltmeters

Drs. Juergen Kienle and Niren Biswas are currently preparing for the installation of three new tiltmeters at the top of Mount St. Augustine. As the name indicates, the tiltmeters will monitor ground tilts caused by the movement of magma from the interior of St. Augustine toward the surface. The tiltmeters will be in place and ready to provide critical information before and during the next and subsequent eruptions. The information from the tiltmeters will be used to forecast imminent eruptions.

Tilt measurements are a very important parameter for predicting volcanic eruptions. Until now, scientists have relied solely on seismic data and overflights of the volcano for information on precursors to eruptions. During the 1986 eruption of St. Augustine, tilt data likely would have made scientists aware of the second, dome-building phase. Unfortunately,

bad weather prevented technicians from observing important details of that phase of the eruption until it was over.

St. Augustine volcano likely will erupt again in five to ten years. The volcano has erupted six times: 1812, 1883, 1935, 1963-64, 1976, and 1986, since its discovery by Captain Cook on St. Augustine's Day in 1778. The highly explosive nature of St. Augustine's eruptions and the short time between eruptions make it the most hazardous volcano in the most populous part of Alaska. Although lava flows are rare, the powerful emission of ash poses considerable hazard to aircraft.

Tsunamis are a special hazard of St. Augustine. In 1883, a dry debris avalanche produced by collapse of the volcano caused ten-meter-high waves at settlements on the lower Kenai Peninsula. Tilting of the upper slopes of the volcano probably preceded the collapse. It is thus very important to improve the monitoring of this volcano's eruptions to avoid casualty.

In the future, monitoring will include tilt studies at the summit region. Coarse and fine tilt information will be transmitted from sensors on the mountain via VHF radio to Homer and from there via the state microwave circuit to the Geophysical Institute Seismology Laboratory. The tiltmeters that are being installed on St. Augustine are the first to be installed on an Alaska volcano.

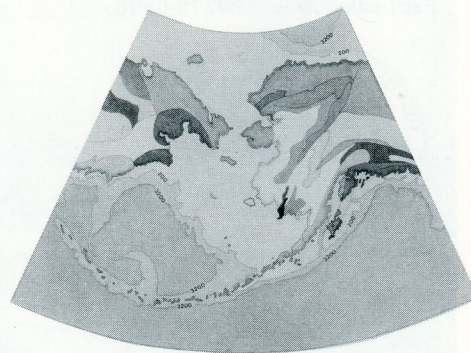


Mount St. Augustine volcano, location of the new tiltmeters. This photo, taken by G. Gunkel, is of the 1976 eruption.

Magnetometers and More

Since 1966 researchers working in solid earth physics at the Geophysical Institute have been analyzing data on the magnetic properties of the bedrock. Paleomagnetic techniques are used to (1) determine the ancient magnetic field of the earth at the time of origin of a rock, and (2) determine the amount of heating a rock has been subjected to over time. Using the direction of the ancient magnetic fields "recorded" in Alaskan rocks, Dr. David Stone and others have tracked the ancient latitudes of geologic plates or "terranes" of southern Alaska. The work done at the Geophysical Institute and at other paleomagnetic laboratories indicates that about 200 to 250 million years ago much of southern Alaska was at equatorial latitudes. The terranes have since moved north to their present location. Similar work is being done on the bedrock in arctic Alaska, but the amount of movement seen there is much smaller than that of southern Alaska.

The tools used at the Geophysical Institute for paleomagnetic studies include "spinner" magnetometers, a cryogenic (extremely low temperature) magnetometer, thermal and alternating field demagnetizers, a magnetic susceptibility bridge, and other equipment such as rock saws and drills. The most recent addition to the paleomagnetic laboratory is the superconducting cryogenic magnetometer. It includes a new computer to run it and to process and store the data. Another recent acquisition is an instrument to measure the magnetic susceptibility of rock. This instrument has a furnace attachment for studying changes in the magnetic properties of a sample with temperature.



The major terranes in Alaska are shown on this map. New equipment in the paleomagnetic laboratory will help define the geologic history of these terranes.

Recent Grants and Contracts

SOUNDING THE IONOSPHERE

A Digital Ionospheric Sounding System (DISS) will be available this summer to the Geophysical Institute from the U.S. Air Force. This equipment will be installed at the Institute's Sheep Creek field site, under the engineering supervision of Brett Delana, so that Dr. Bob Hunsucker and other researchers can study auroral ionospheric disturbances in Alaska. Polar ionospheric and auroral irregularities are known to interrupt high-frequency communications systems. Data collected at this site will not only improve our understanding of geophysical phenomena governing the high-latitude ionosphere, but will also provide an improved description of the environment for Air Force communications systems.

The Sheep Creek installation will include an antenna array and tape recorders. The DISS system will "sound" the ionosphere in a manner similar to sounding by radar, and the data will be taped. The data collecting will likely begin in September 1987, and will continue on a long term basis. These data will provide a

description of the morphology of irregularities in the auroral and subauroral oval. Variations in the ionospheric layers due to day-night changes, seasonal changes, magnetic storms, and other phenomena will be recorded.

GRAVITY WAVES

Dr. David Fritts was recently awarded a U.S. Air Force grant to continue his detailed radar studies of gravity waves in the lower stratosphere. Past studies by other researchers have shown that gravity waves have a significant influence on large-scale circulation in the lower thermosphere and mesosphere, which are atmosphere layers above the stratosphere. For this research project, Dr. Fritts is concentrating on the similar influence that gravity waves have on the dynamics of the stratosphere and upper troposphere. The study will increase our knowledge about the origin of gravity waves at these altitudes and their effects, such as turbulence.

FLUX TRANSFER EVENTS

Dr. Lou Lee has been awarded a continuation of his National Science Foundation grant for studying plasma processes at the earth's magnetopause, magnetotail, auroral ionosphere, and in the ionosphere of Venus. His studies are an attempt to explain flux transfer events. (The logo on the front page of this *Quarterly* shows the earth's magnetic field. Solar wind moves from left to right and causes FTEs on the far left.)

Dr. Lee's theory involves a multiple x-line reconnection process, which refers to the reconnection of magnetic field lines after solar wind enters into the earth's atmosphere. The results of his studies are expected to enhance our understanding of the solar wind-magnetosphere-ionosphere interaction as well as the magnetic reconnection process.

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