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Public Safety vs. Augustine's Eruption

Although all scientific work on hazardous natural phenomena such as weather, earthquakes, and volcanic eruptions can advance the public safety, sometimes direct considerations of safety demand specific actions. These actions are normally at the fringes of scientific research and become important only during some crisis, as in the eruption on March 27, 1986, of Augustine Volcano. That eruption called for coordinated action among several agencies, in an attempt to communicate in the most meaningful way possible a prediction of what could happen next and how it would affect the public. The agencies involved were the Geophysical Institute, the Alaska Division of Geological Surveys (DGGS), and the U.S. Geological Survey (USGS).

In February 1982 DGGS sponsored a meeting on seismic, volcanic, and tsunami hazards in Alaska. Following this meeting an informal agreement and a pooling of resources among the Geophysical Institute, DGGS, and USGS created a minimal Cook Inlet volcano monitoring capability at the Anchorage USGS office in Gould Hall. In addition to monitoring each of the Cook Inlet volcanoes from Augustine to Spurr, this informal "observatory" served as a continual reminder of the need to formalize a national research program centered on Alaska's volcanoes, to seek stable funding, and to decide how each agency would respond to a future volcanic event.

A Geophysical Institute report published by Juergen Kienle and Samuel Swanson in February 1985 gave a detailed chronology and description of the previous eruptions of Augustine, especially those of 1963-64 and 1976. The generalized sequence of events in the previous eruptions was the scientific basis for the forecasts made at various stages of the 1986 eruption. Of course, none of the eruptive sequences were identical, so frequent reinterpretations of the events were necessary to assess the potential for future eruptive activity.

The first indication that Augustine was reawakening was a swarm of microearthquakes in July 1985. Our level of concern began to accelerate in February as the seismicity and the frequency of reports of fumarolic activity increased. In mid-March the USGS arranged meetings to brief the Federal Aviation Administration (FAA), the Air Force (USAF), and the State Division of Emergency Services on the potential hazards from an eruption of Augustine Volcano. On March 22, with support from DGGS, Geophysical Institute scientists visited Augustine to repair some of the existing seismic stations and to install one additional station, bringing the total on the island to five. On March 26 a dramatic increase in the seismicity rate from a few hundred events per day to 6,000 per day prompted an informal prediction that the volcano would soon erupt: it did, at two o'clock the next morning.

The demand for information during the first phase of the eruption was overwhelming. As many state and local agencies were referring calls to the USGS, the major burden of providing information fell on the Gould Hall staff, who remained on duty around the clock during this phase. Personnel from DGGS and the Geophysical Institute kept a 24-hour-a-day watch at the Institute's Seismology Lab. Volcanologists from the USGS Cascade Volcano Observatory in Vancouver, Washington, assisted both at Gould Hall in Anchorage and at the Seismology Lab in Fairbanks.

Because the seismic events were again increasing, at an information meeting in Homer on April 22 a second informal prediction was made that a dome-building phase would soon begin. With the continued increase in event counts on the 23rd, the prediction was communicated to the FAA, the USAF, the Coast Guard, and the State Division of Emergency Services as well as to the press.

A new dome was emplaced during the period April 24-27. This phase was not accompanied by dramatic eruptive plumes (a possibility mentioned in the prediction given to the press), leading the media initially to report this as a failed prediction, while in fact it was in its main aspect completely correct.

Between and following the two main phases of the eruption, volcanologists from USGS, DGGS, and the Geophysical Institute visited the volcano to map and sample the flows, to repair the seismic stations, and to survey geodetic deformation networks. During the summer field season we hope to complete several research projects that will allow improved predictions of future eruptions of Augustine.

John Davies
Alaska State Seismologist, DGGS

VOLCANO

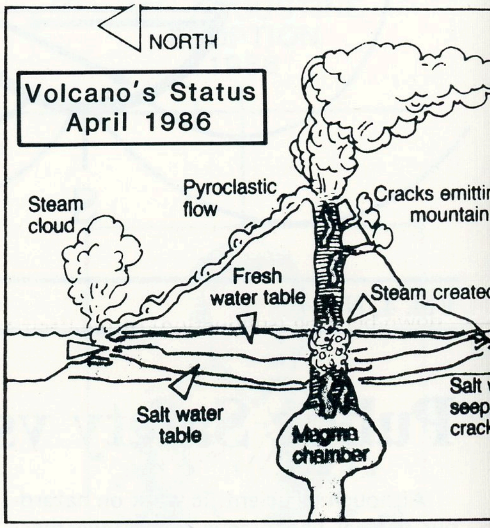
AUGUSTINE ERUPTS AGAIN

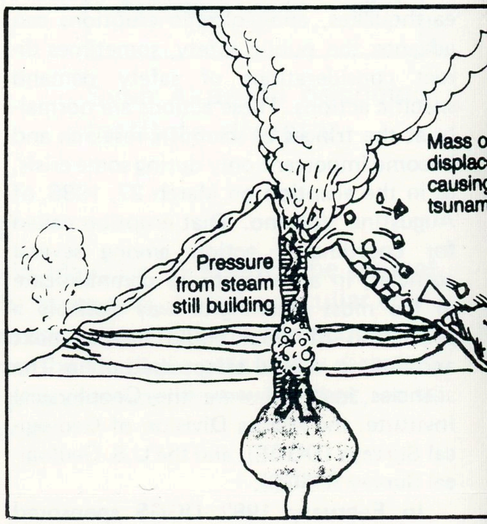
A series of powerful explosions, March 27-31, 1986, sent eruption clouds into the stratosphere and generated flows of heat-shattered rock (pyroclastic pumice) that reached the sea. Augustine Volcano, 180 miles southwest of Anchorage, had erupted once more. To Juergen Kienle and other seismologists at the Geophysical Institute, this eruption came as no surprise. Kienle has been monitoring Augustine with four radio-telemetered seismic stations and occasional visual overflight observations. Last July the first swarm of earthquakes was recorded there and by mid-February 1986, vigorous steaming at the summit was observed. This monitoring setup, although on a fairly small scale, proved to be one of the best opportunities in the United States to test volcano forecasting theories. A clear exponential buildup of seismicity allowed a prediction eight hours before the first eruption.

For the general public, the first indication of the eruption was seen by observers in Homer and on fishing boats 35 miles southeast of the volcano. They reported "orange flashes" and "smoke and fire" from the volcano early on March 27. For several days afterward the volcano had direct effects on the environment. Air traffic was disrupted at Anchorage International Airport because of ash clouds in the area. The windshield and parts of the turbines of one DC-10 were abraded by the sharp angular ash fragments while the plane descended to Anchorage in near zero-visibility conditions. Anchorage businesses closed early March 27, to cut down on electricity use because of potential damage to turbine generators. An air quality health alert was in effect March 28 because of high particulate concentrations.

On April 19, almost three weeks after the eruption, Kienle and others were able to visit uninhabited Augustine Island by helicopter. As they walked on the pumice flows, they sank up to their knees, observed charred driftwood on the beach, and measured temperatures of up to 550°C only 5 cm deep in fumarole pipes. They calculated that 0.11 cubic kilometers of material had been ejected from the volcano (equivalent to a cube with each side as long as five football fields!). Later, during an April 28 visit, Tom Miller of USGS collected still-glowing blocks of new dome material for analysis, which showed that the new melt is chemically similar to lava from Mount St. Helens.

Augustine has been the most active volcano in the Cook Inlet region, having erupted in 1812, 1883, 1935, 1963-64, 1976, and 1986. This frequency indicates that molten material (magma) lies close to the surface. Periodically, this magma and associated gases work their way to the surface. The shortening eruption interval from 71 to 52, 28, 12, and 10 years suggests that this 1986 eruption will not be Augustine's last.





The uppermost diagram shows Augustine's activity during the eruption. The lower diagram shows wh happened if magma pressure had blown off a large mountain's south side or if a section of the volcano Such a catastrophic eruption is not necessarily exp continuing possibility for future eruptions. (*An News,* Dee Boyles.)

This photograph of Augustine Volcano, taken April 19, 1986, shows the eruption column extending to the southwest. The fan of new pumice flows can be seen on the northern flank of the volcano. (Photo by Juergen Kienle.)

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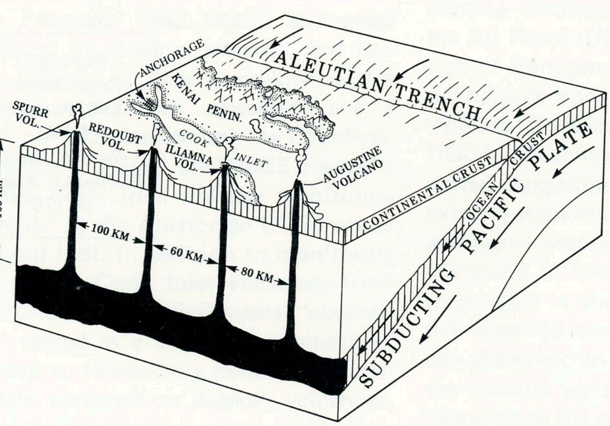
VOLCANOES IN ALASKA

Only in the last 20 years have scientists substantiated the theory that explains volcanoes and earthquakes. They now think that the earth's surface consists of a dozen or so rigid plates that move against one another. In some places the plates grind past each other sideways and cause earthquakes. In other areas, plates collide so that one is forced beneath the other, causing both earthquakes and volcanoes at the boundary.

In southern Alaska, the Pacific plate is being thrust under the North American plate. The Aleutian Trench is caused by the down-bending (subduction) of the Pacific plate. Volcanoes occur when melt is generated at a critical depth and the molten material comes to the surface (see figure below). Alaska has more than 10% of the world's volcanoes within its boundaries, and this provides an excellent laboratory for chemists, physicists, and geologists studying earth processes.

Certain volcanoes have been consistent performers. Both Pavlof and Shishaldin have erupted more than 20 times in the past 200 years, but these eruptions have been of small magnitude. The Mount Katmai eruption of 1912 was the most spectacular of all historic Alaskan volcanic events, and the largest in the world during the twentieth century. Twenty cubic miles of ash and pumice were ejected, and more than 600 feet of ash was deposited in the Valley of Ten Thousand Smokes.

Although most of Alaska's volcanoes occur along the Aleutian volcanic arc, geologically young volcanoes are also found in the Wrangell Mountains, southeastern Alaska, and western Alaska. Mount Wrangell, Mount Edgecumbe, and the Imuruk lava fields on the Seward Peninsula are examples of these. Volcanoes have been affecting the landscape in Alaska for millions of years and they will continue to do so. Each year one or more of these volcanoes can be expected to show activity that will have an impact on the immediate environment, if not the entire world.



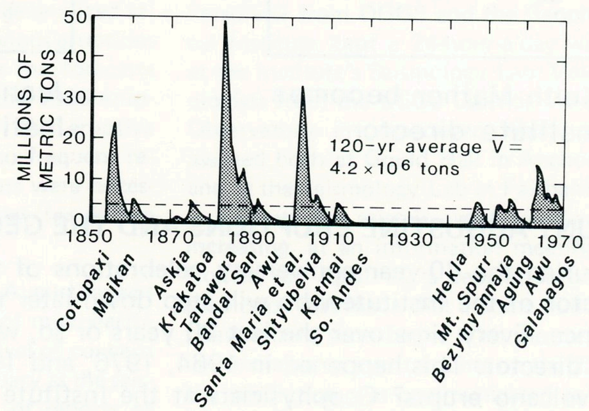
The North Pacific tectonic plate slips beneath the southcentral coast of Alaska, creating an area of stress that spawns volcanoes and earthquakes. Spurr, Redoubt, Iliamna, and Augustine, on the west side of Cook Inlet, all have erupted during recorded history and all have active steam vents. (From N. Davis, *Energy/Alaska,* University of Alaska Press, 1984.)

VOLCANOES AND CLIMATE

In 1816 in New England it snowed in June, and then killing frosts continued through August. The Lancashire plain in England had its coldest July, and the summer as a whole ranked as the coldest on record in Geneva, Switzerland. The chain of events began in 1815 with an immense volcanic eruption in the Dutch East Indies (now Indonesia) when Mount Tambora on the island of Sumbawa threw an immense amount of fine dust into the atmosphere.

The idea that volcanoes have something to do with the climate is not new. Benjamin Franklin invoked it to explain the cold winter of 1783-84. Today the idea is confirmed through extensive temperature records from many parts of the world, which can be compared with the fairly complete record of the volcanic eruptions that have been observed during the past two centuries.

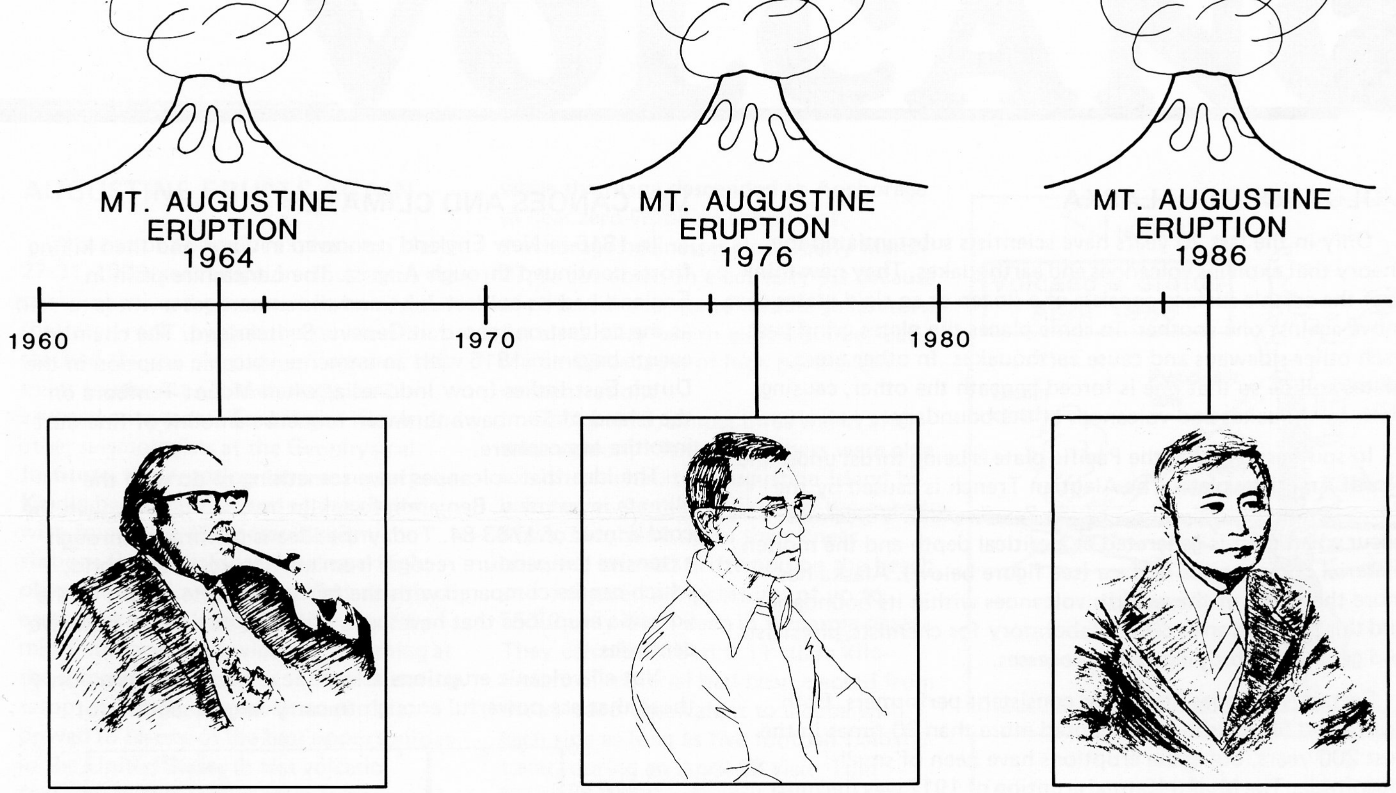
Not all volcanic eruptions affect the climate, however—only those that are powerful enough to carry large quantities of



Amounts of dust in the stratosphere above about 10 miles produced by major volcanic eruptions between 1850 and 1970. (Note several Alaskan eruptions.)

volcanic dust and debris high into the atmosphere (the so-called stratosphere above 10 miles or about 16 kilometers). There, above storms and weather systems that normally remove the dust at lower elevations by precipitation, the dust particles remain for more than a year. They act like a blanket, intercepting the light from the sun and reflecting it back to space. As a consequence, less sunshine reaches the surface of the earth and the temperatures remain lower.

The above graph shows the large amounts of dust carried up into the stratosphere by major volcanic eruptions between 1850 and 1970. The eruption of Krakatoa in 1883 was the most spectacular of these. Recent eruptions, not shown on the graph, were those of Mount St. Helens, El Chichón in Mexico, and Mount Augustine. The El Chichón dust cloud took about seven months to reach Fairbanks and, according to Professor Gerd Wendler who measured its effects on the roof of the Geophysical Institute, reduced direct solar radiation by about 25%, with some effects still being noticeable a year after the eruption.



Keith Mather becomes Institute director

Juan Roederer becomes Institute director

Syun Akasofu becomes Institute director

MOUNT AUGUSTINE ERUPTIONS AND THE GEOPHYSICAL INSTITUTE

During the 40-year anniversary celebrations of the Geophysical Institute in May, Dr. Roederer, the present director of the Institute who will step down later this year when Dr. Akasofu takes over, noted a peculiar coincidence. Every time over the last 20 years or so, when Mt. Augustine has erupted, the Institute has acquired a new director. This happened in 1964, 1976, and 1986. Or is it that every time the Institute gets a new director, the volcano erupts? Geophysicists at the Institute are keenly studying this phenomenon, but warn that, as so often is the case, the data base is as yet too small to make any reliable predictions.

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