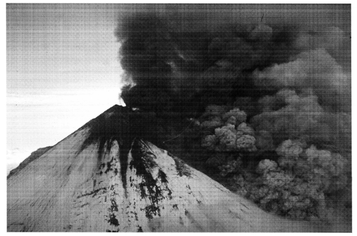
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 97-135

STROMBOLIAN ERUPTIONS AT PAVLOF VOLCANO AND HAZARDS FROM VOLCANIC ASH CLOUDS



The upper photo shows pulses of dusty volcanic ash erupted during rhythmic explosions in 1986. The lower photo shows a steam and ash plume produced during a sustained explosion in 1986.

Pavlof Volcano and its satellite vents, Pavlof's Sister and Little Pavlof, are near the western tip of the Alaska Peninsula, about 950 km southwest of Anchorage, Alaska. Pavlof has been one of the most active volcanoes in the Aleutian volcanic arc, with more than 30 known periods of volcanic activity since the mid-1700's. Both Pavlof's Sister and Little Pavlof are Holocene in age, but neither are known to have erupted in historic time. This preliminary hazard assessment does not include these volcanoes.

Pavlof Volcano has a *strombolian* eruptive style. Strombolian eruptive activity consists of a series of explosions at the surface of a magma column caused by the rapid expansion of magmatic gasses. These discrete explosions generally last a few seconds or less and may be rhythmic or intermittent. The explosive bursts are often distinctly audible as a rumbling or thunder-like noise.

Strombolian explosions usually eject fragments of hot, glowing spatter to heights of tens to hundreds of meters above the vent. Typical exit velocities are about 100 meters per second. At night, these glowing fragments trace parabolic paths as they fall back into the vent or onto the volcano's flanks. Occasionally, the explosions can be so closely spaced in time that the glowing ejecta forms spectacular rooster-tail shaped lava fountains extending 100 meters or more above the vent.

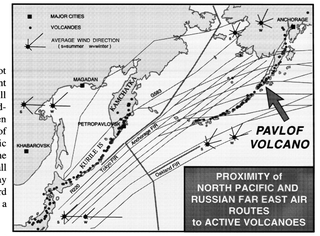
In a typical strombolian eruption, the volume of erupted material is usually small (0.01 to 0.1 cubic kilometers of magma) and the eruption column may reach only a few hundred meters above the vent. Usually, a sustained eruption column does not develop and relatively little volcanic ash (tephra) is erupted (unlike the more vigorous eruptions of Redoubt and Mount Spurr Volcanoes). During many Pavlof eruptions, a series of brownish pulses of dusty tephra climb to heights of a few hundred meters above the vent before being rapidly dispersed by the wind. During vigorous Pavlof explosions, these pulses of tephra reach heights of 5 to 7 kilometers above the vent. Volcanic ash could extend as high as 11 kilometers above the vent during extreme, but rare eruptions.

Pavlof Volcano, September 29, 1996. The dark linear bands are spatter-fed lava flows. These flows extend almost to the base of the volcano. The other dark-colored areas near the summit are spatter-fed pyroclastic debris aprons. Note the small "puff-like" ash plume which is typical of strombolian eruptions. Photograph courtesy of Aeromap, U.S.

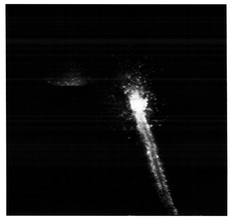
HAZARDS FROM AIRBORNE ASH AND ASH FALLOUT

Although emissions of volcanic ash from Pavlof are generally not voluminous, communities near the volcano can receive frequent light dustings of fine ash. The amount of ash carried by the wind will depend on wind speed and direction. Most ash clouds consist of sand-sized and smaller ash particles, steam, and other gasses. An ash-laden plume is typically dark colored, whereas plumes composed mostly of water vapor and volcanic gas (generally present in non-toxic concentrations) tend to be light colored. Aircraft flying near the volcano could be affected by even small amounts of tephra and all visible tephra plumes should be avoided. Because tephra bursts may extend 5 to 7 kilometers above the volcano there is a substantial hazard to all aircraft especially at night when it would be difficult to detect a tephra plume.

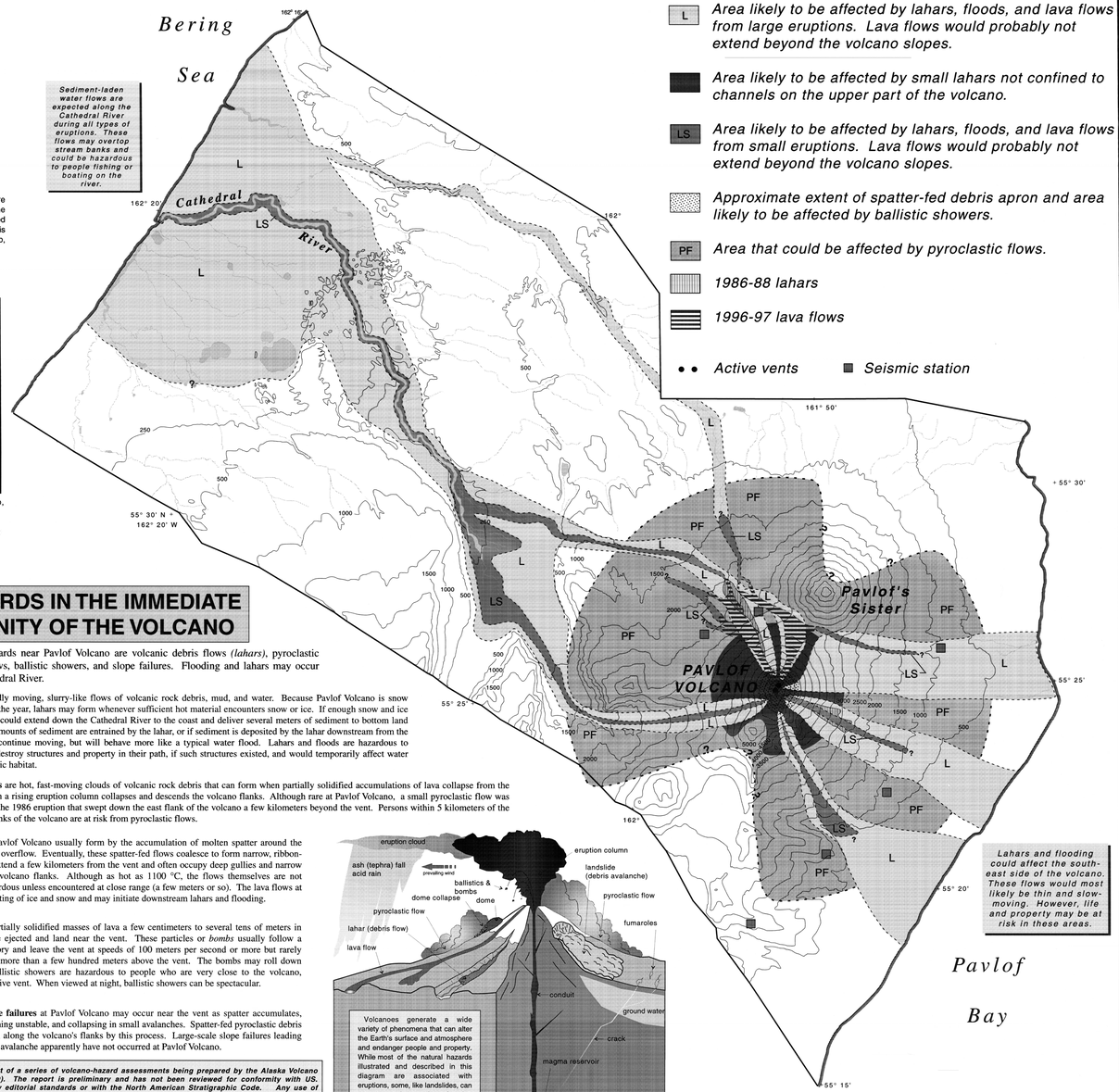
Tephra fallout from Pavlof Volcano may be a nuisance to people and may damage water supplies, machinery and electronic equipment. Although unlikely, heavy tephra fall could collapse buildings.



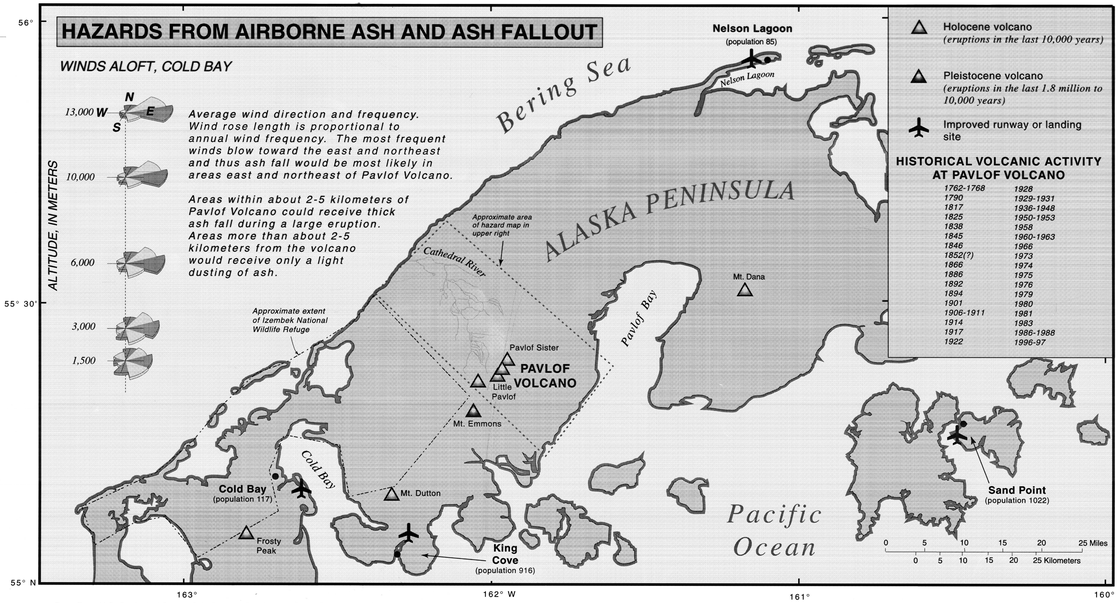
Jet aircraft traveling the North Pacific and Russian Far East air routes pass over or come close to numerous active volcanoes including Pavlof. During eruptions, clouds of volcanic ash often occupy the airspace used by these aircraft. Many thousands of people per day and a vast amount of air cargo are transported via these air routes.



Night view of strombolian eruption at Pavlof Volcano, September 29, 1996. Strombolian activity at the southern vent (right) feeds a lava flow. Mild strombolian activity is occurring at the northern vent (left).



HAZARDS FROM AIRBORNE ASH AND ASH FALLOUT



Base From U.S. Geological Survey Cold Bay and Port Moller, Alaska Quadrangles, scale 1:250,000.

Population data from Aleutians East Borough, 1995

HAZARDS IN THE IMMEDIATE VICINITY OF THE VOLCANO

Significant hazards near Pavlof Volcano are volcanic debris flows *(lahars)*, pyroclastic flows, lava flows, ballistic showers, and slope failures. Flooding and lahars may occur along the Cathedral River.

Lahars are rapidly moving, slurry-like flows of volcanic rock debris, mud, and water. Because Pavlof Volcano is snow covered most of the year, lahars may form whenever sufficient hot material encounters snow or ice. If enough snow and ice is melted, lahars could extend down the Cathedral River to the coast and deliver several meters of sediment to bottom land areas. If lesser amounts of sediment are entrained by the lahar, or if sediment is deposited by the lahar downstream from the volcano, it will continue moving, but will behave more like a typical water flood. Lahars and floods are hazardous to humans, would destroy structures and property in their path, if such structures existed, and would temporarily affect water quality and aquatic habitat.

Pyroclastic flows are hot, fast-moving clouds of volcanic rock debris that can form when partially solidified accumulations of lava collapse from the vent area or when a rising eruption column collapses and descends the volcano flanks. Although rare at Pavlof Volcano, a small pyroclastic flow was observed during the 1986 eruption that swept down the east flank of the volcano a few kilometers beyond the vent. Persons within 5 kilometers of the vent or on the flanks of the volcano are at risk from pyroclastic flows.

Lava flows at Pavlof Volcano usually form by the accumulation of molten spatter around the vent or by direct overflow. Eventually, these spatter-fed flows coalesce to form narrow, ribbon-like flows that extend a few kilometers from the vent and often occupy deep gullies and narrow canyons on the volcano flanks. Although as hot as 1100 °C, the flows themselves are not particularly hazardous unless encountered at close range (a few meters or so). The lava flows at Pavlof cause melting of ice and snow and may initiate downstream lahars and flooding.

Ballistics are partially solidified masses of lava a few centimeters to several tens of meters in diameter that are ejected and land near the vent. These particles or *bombs* usually follow a parabolic trajectory and leave the vent at speeds of 100 meters per second or more but rarely reach heights of more than a few hundred meters above the vent. The bombs may roll down steep slopes. Ballistic showers are hazardous to people who are very close to the volcano, especially the active vent. When viewed at night, ballistic showers can be spectacular.

Small-scale **slope failures** at Pavlof Volcano may occur near the vent as spatter accumulates, eventually becoming unstable, and collapsing in small avalanches. Spatter-fed pyroclastic debris aprons may form along the volcano's flanks by this process. Large-scale slope failures leading to a major debris avalanche apparently have not occurred at Pavlof Volcano.

Modified from Meyers and Brantley, 1995, USGS Open-File Report 95-231

This report is part of a series of volcano-hazard assessments being prepared by the Alaska Volcano Observatory (AVO). The report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. The report is subject to revision as new data become available.

The Alaska Volcano Observatory was established in 1988 to carry out volcano monitoring, eruption notification, volcanic hazard assessments, and volcano research in Alaska. The cooperating agencies of AVO are the U.S. Geological Survey, the University of Alaska-Fairbanks Geophysical Institute, and the Alaska Division of Geological and Geophysical Surveys. During summer 1996, six seismic monitoring stations were installed on Pavlof Volcano, as part of a larger initiative to expand the volcano monitoring and eruption response network supported by AVO. Funding for this initiative came from the Federal Aviation Administration with additional support from the U.S. Geological Survey and the State of Alaska.

PRELIMINARY VOLCANO-HAZARD ASSESSMENT FOR PAVLOF VOLCANO, ALASKA

By

Christopher F. Waythomas, Thomas P. Miller, Robert G. McGimsey, and Christina A. Neal

1997