

Mount St. Helens Eruption—1980

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Mount St. Helens Eruption

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SUNDAY, May 18, 1980 . . . a magnificently clear, bright morning. Three rope teams of four persons each had set out before dawn to reach the summit of 12,307-foot (3751 meters) Mount Adams, Washington State's second highest peak. At 8:32 A.M., as they approached the top of this glacier-clad volcano, they paused to enjoy the unparalleled view of sister volcanoes Mount Rainier (14,410 feet, 4392 meters), 50 miles to the northwest and Mount St. Helens (9,677 feet, 2930 meters), 35 miles west. One of the climbers, Fred Grimm, suddenly stopped and gasped.

Later he reported: "First it was a little puff at the top of the mountain (St. Helens). Then, within two or three seconds, it appeared that the north side of the mountain just blew out. The whole top of the mountain was engulfed in the column of smoke. It rose like an atomic explosion . . . with sort of a shock wave that went to the north. It reminded me of the pictures you see on late-night TV of the world blowing up."

"Suddenly the wind that had been blowing over us stopped," Grimm also recalled. "The volcano seemed to suck up the wind and it didn't come back for four or five minutes." A vast black cloud began filling the sky overhead, blotting out the sun. Then it came . . . the heavy fall of volcanic debris, pelting the climbers first with a fine hail-like material, then bigger pieces, pebble-size, and some even larger, mixed with singed and sand-blasted pine cones from the vanishing mountain, which by then was obscured by the enveloping cloud of ash.

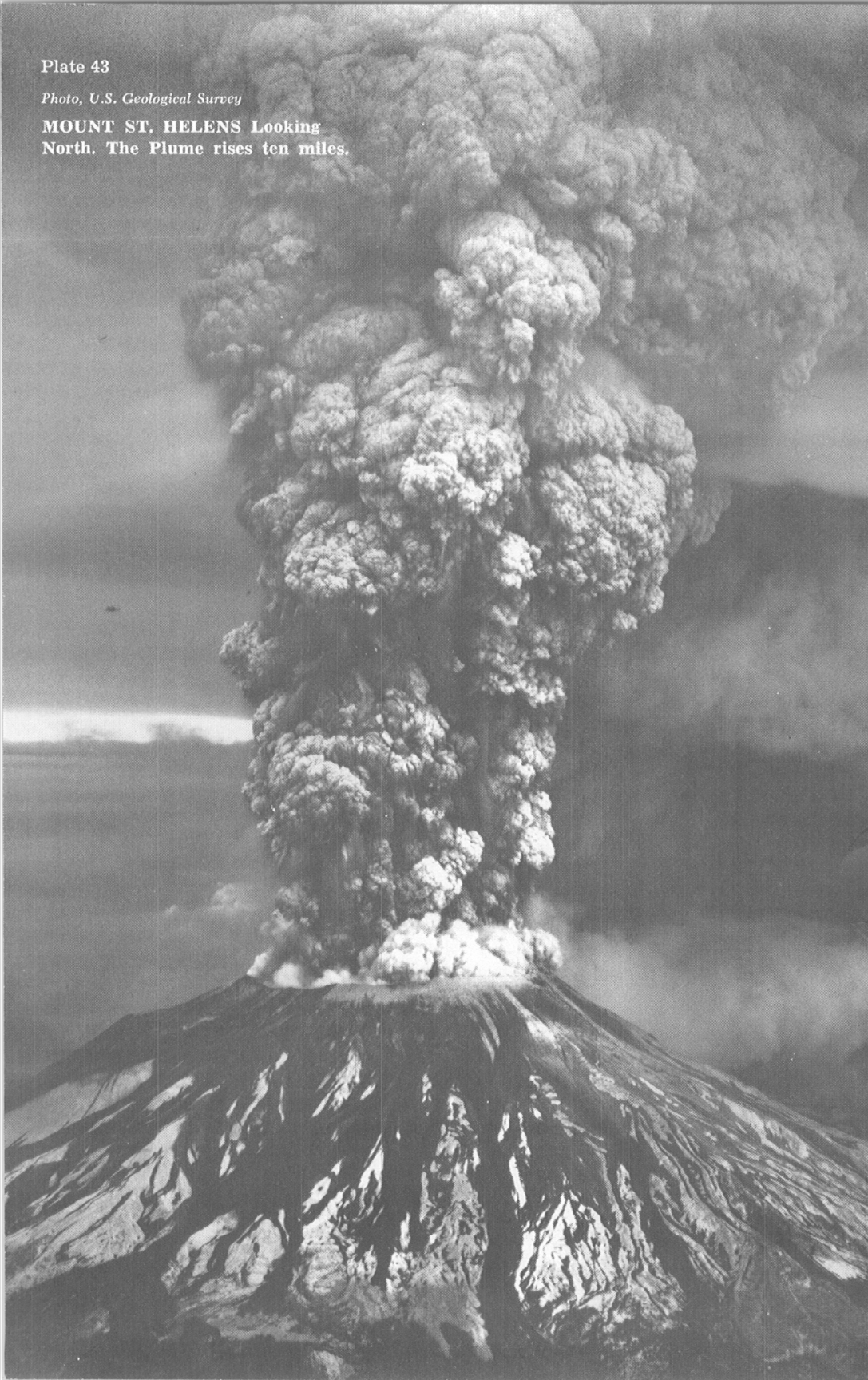
There is no evidence that any climbers were on Mount St. Helens at the time of the eruption. About the same time that the Mount Adams climbers were watching the event from afar, Keith Stoffel, a staff geologist with the Washington State Division of Geology and Earth Resources, was taking photographs from a private plane, 3000 feet directly above the Mount St. Helens summit. As he and his pilot crossed the west edge of the crater, they saw a massive landslide of volcanic rock and broken glacial ice catapulting into the center of the crater. A precursor of the main event, this was a response to major earthquake activity at depth.

"Within a matter of seconds, perhaps 15 seconds, the whole north side of the summit crater began to move instantaneously," Stoffel recalled. "As we were looking directly down on the summit crater, everything north of a line drawn east-west across the northern side of the

Plate 43

Photo, U.S. Geological Survey

**MOUNT ST. HELENS Looking
North. The Plume rises ten miles.**



summit crater began to move as one gigantic mass. The nature of the movement was eerie, like nothing we had ever seen before. The entire mass began to ripple and churn up, without moving laterally. Then the entire north side of the mountain began sliding to the north along a deep-seated slide plane down toward Spirit Lake."

It is now clear that this great slide in effect "removed the cork from the bottle," permitting pent-up heat to erupt with explosive violence and to spew nearly a cubic mile of pulverized mountain into a 160° sector to the north.

Close to the base of the mountain was death and devastation. David Johnston, 31, a geologist with the U.S. Geological Survey, was at an observation post on Coldwater Ridge, six miles north of the mountain's crater and 1200 feet above the Toutle River. At 8:32 A.M. he screamed into his portable radio "Vancouver, Vancouver, this is it!" Then the radio went dead. His observation post was struck by the momentum of the initial landslide carrying debris over the crest of the ridge, removing forest and soil cover to depths in excess of a meter. Dr. Johnston's body has never been found.

Missing, too, is the body of a man whose press interviews in the preceding weeks had made him a media hero . . . Harry R. Truman, a crusty 83-year old mountain man and lodge-owner at Spirit Lake. Some weeks before the eruption he had told an interviewer: "If the mountain goes, I'm gonna stay right here. I stuck it out 54 years and I can stick it out another 54." His safety plan was to hide in a nearby mine adit with a bottle of whiskey.

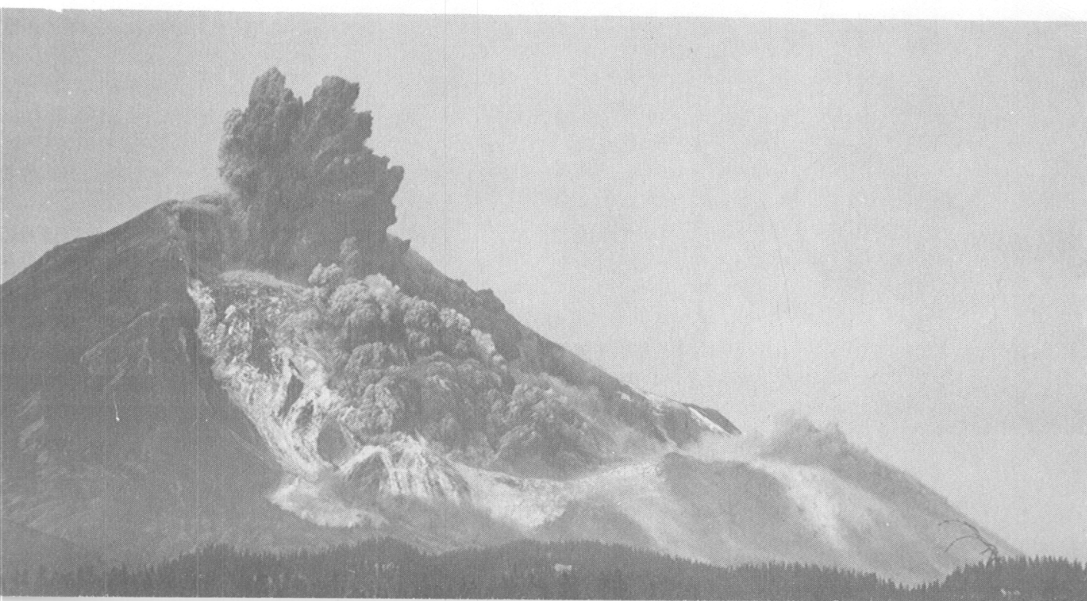
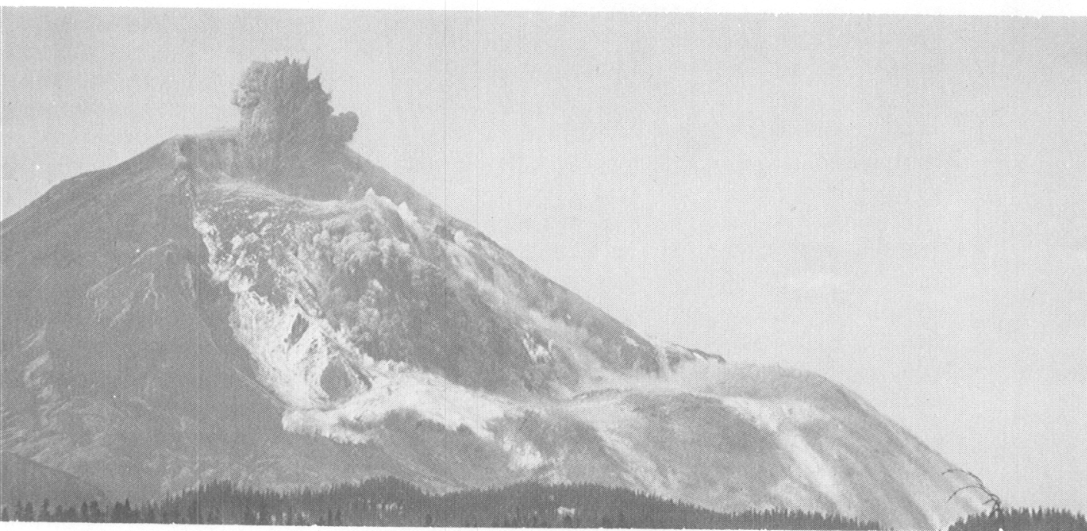
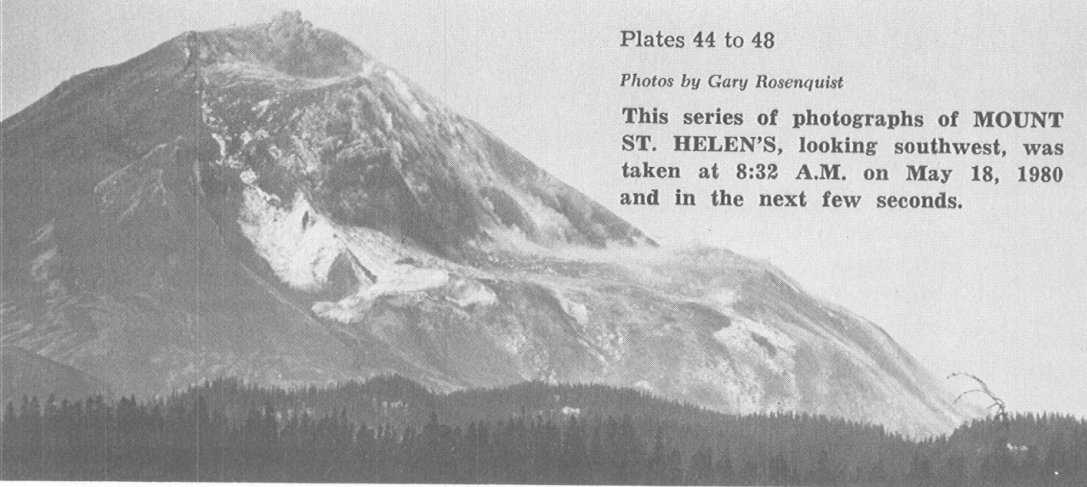
But on that morning, his lodge was buried beneath an onslaught of 100-foot-deep ash, toxic gasses and parts of the first debris-fan which slid downward from the breached crater into Spirit Lake, adding a half-mile to the south shore and raising the lake level over 120 feet. Also killed was Jim Fitzgerald, 28, one of our Ph.D students at the University of Idaho, whose thesis research was on volcanic geology. Jim's body was later found in his car, half-buried by ash. Eight months later the U.S. Forest Service shipped us a 300-pound "volcanic bomb," a huge boulder ejected from the explosive gash and deposited not far from Jim's undated vehicle. This will be set up outside our Mines Building with a bronze plaque attached dedicated to his memory. Some 61 people lost their lives on that tragic morning. Over the next few days another 198 persons were evacuated by helicopter from the devastated area, many injured and in various states of shock.

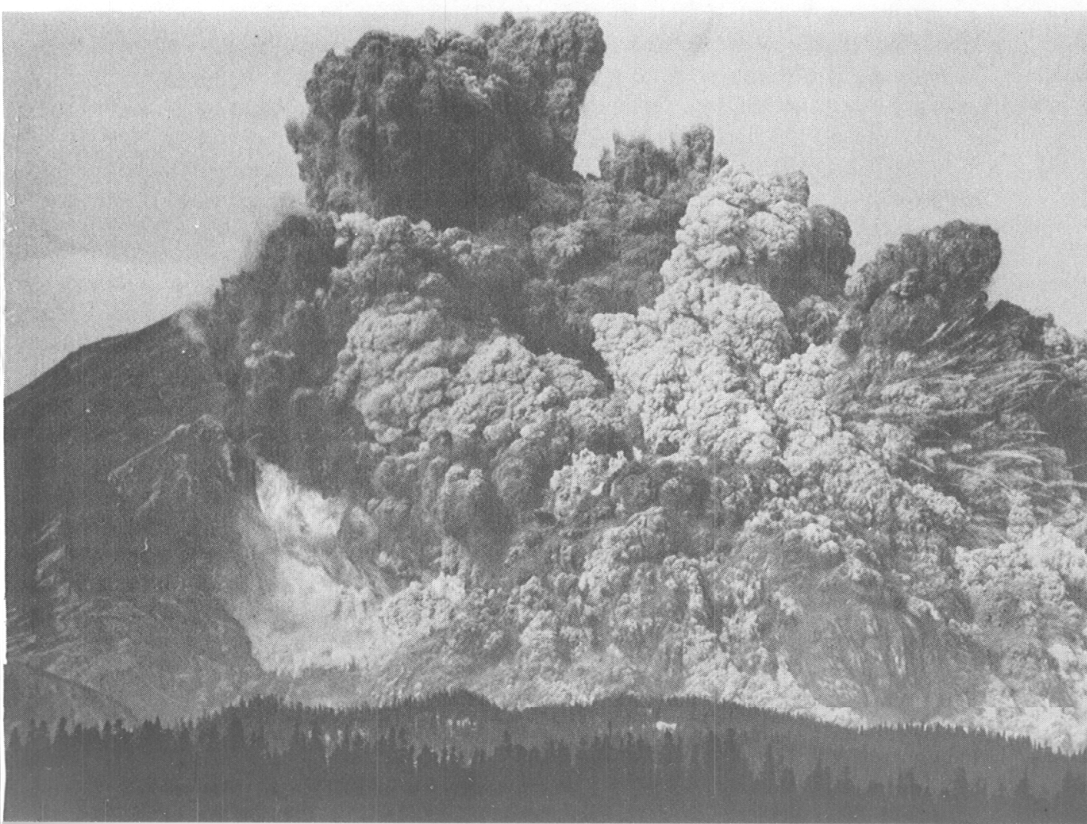
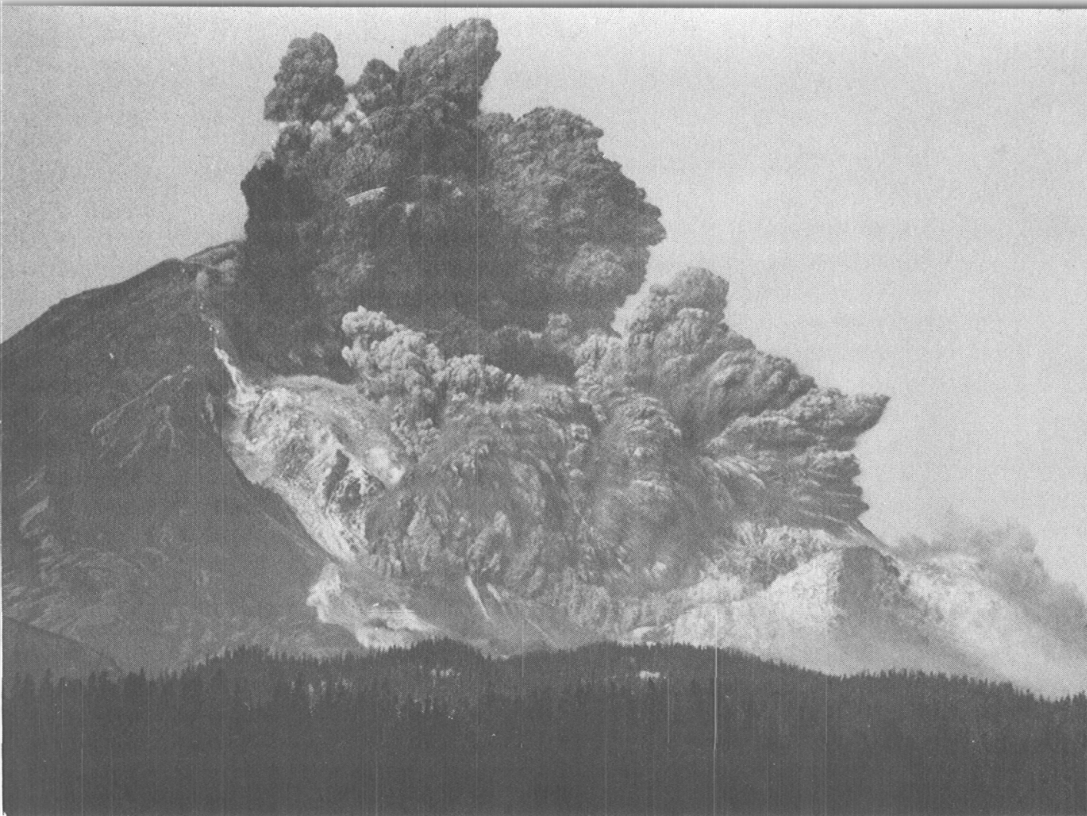
My wife, Joan, and I were luckier, living several hundred miles away. Around noon as we headed out of town for a Geology Department picnic, we noticed a darkening sky, and as we had heard no news that day, assumed that a storm was approaching. As the sky continued to darken, some of the geologists suggested moving the party inside "before the rains come." First we noticed that the birds had stopped

Plates 44 to 48

Photos by Gary Rosenquist

This series of photographs of MOUNT ST. HELEN'S, looking southwest, was taken at 8:32 A.M. on May 18, 1980 and in the next few seconds.





singing; then that the farm animals had bedded down. The horses took careful handling to get into the barn as the ominous total eclipse descended by three P.M. In the 70° heat, "snow" began to fall . . . but they were ash clasts pattering upon us. By midnight, five inches of ash had covered the ground at Yakima, 80 miles downwind from the mountain.

The records of the Western Washington Seismic Network showed a 5.1 magnitude earthquake on the Richter Scale at 8:32 A.M. on May 18. This was the largest quake recorded since close observation of the mountain had begun following 4.1 and 4.4 magnitude earthquakes affecting the area on March 20 and 25. It was then that the University of Washington Geophysics Department placed four additional monitoring stations in the field to keep closer tab on a series of seismic events, including several more 5.0 quakes and associated harmonic tremors and upbulging of the north side of the mountain . . . preludes to the May 18 explosion.

From eyewitness descriptions and interpretation of ground photographs taken by a number of observers and from aerial photographs taken by the U.S. Geological Survey and by Charles R. Rosenfeld of Oregon State University, who serves as imagery interpretation officer for the Oregon Army National Guard, it is revealed that the triggering involved the following sequence of mechanisms: (1) the 5.1 magnitude quake signalled movement of material at depth; (2) the resulting landslide seen by Stoffel detached much of the bulging north crater rim; (3) a consequent reduction in pressure on heated ground-water made it flash into super-heated steam that, combined with explosive gas, propelled ash-laden steam in a horizontal trajectory northward across the Toutle River Valley. (4) The exploding steam further fractured and loosened a capping of volcanic rock, resulting in sudden downward collapse of the crater along fault surfaces on the sides of a graben which had developed in the summit sector a few weeks before. (5) An explosive release of magmatic gasses was followed by (6) development of gigantic vertically rising plume of ash out of the north flank of the breach, the plume ascending to 63,000 feet and trailing off to the northeast. Heavy convective upwelling occurred within the rising column and a vast mushroom cap expanded outward at an altitude of about 45,000 feet. (7) During the main eruptive phase that lasted for several hours (continuing to a lessened degree for 19 hours), there was further enlargement and deepening of the crater and lowering of the peak's summit elevation by some 1300 feet (400 meters).

The ash plume was characterized by a high strataform debris mass of finely pulverized rock at 50,000 to 63,000 feet, and a denser irregular plume casting segments of heavier ash at 30,000 to 40,000 feet. Beneath

this was a diffused and broken zone with globular pockets of airborne ash, probably related to the initial blast, with particles suspending downward to 15,000 feet.

An atmospheric sampling aircraft measured median particle sizes in the mid-level zone of the plume at 1 to 3 microns as close as seven miles from the crater. (This compares with what we were later to find deposited on the ground as a blanket of gray "snow" in eastern Washington and the Idaho Panhandle.) The upper plume segment was destined to carry suspended material across the United States, spreading laterally from Alabama to Maine. The plume's lower leading edge reached the Idaho border by noon with the main dense cloud turning bright day into total darkness in Idaho and western Montana by midafternoon. In the next several days, some of the finest particles remained in the stratosphere, completely encircling the earth. We now know that the ash plume extended from just south of Lewiston, Idaho, to the Canadian line. On the Washington-Idaho border the ash cover was 18 to 20 kilograms per square meter or about 10 tons per acre. It was 100 tons per acre in the Yakima Valley!

In the 48 hours following the eruption, my phone in the Idaho Bureau of Mines and Geology rang incessantly, bringing questions from concerned citizens, some of whom were sure that Armageddon had arrived. The Washington State Geological Division and the U.S. Geological Survey in Vancouver, Washington were besieged with even more calls. The first task was to determine the physical and chemical character of the ash. Within a few hours after the eruption, microscopic and microprobe analyses,* carried out by Charles Knowles of our staff, determined that the ash was comprised of chemically inert silicon, fortunately non-toxic and non-acidic, with pH of 5.5 close to that of normal rain water. Our information was released to the media immediately to calm public fears and to dispel wild rumors circulating about high acidity and health and farm crop risks. Fortunately, our analyses showed none of the dangerous characteristics found in ashfalls from Katmai in the Alaska Peninsula in 1912. But under the microscope we saw volcanic shards as jagged as pieces of shrapnel which, if breathed over prolonged periods, could damage the lungs. We urged the public to wear masks when working outside.

It was well into summer before the ash blanket was removed from streets of cities and towns in the path of the fallout. Even now, almost a year later, the ash filters out of tree branches that overhang my driveway, mottling my car a grayish white after every wind or rain storm.

Evidences of the devastation in a 200-square-mile area close to the mountain are too numerous to cite. The impact was so staggering that it might serve as an example of what to expect if we ever have a nuclear

* Chemical analysis of ash shown in attached table.

MOUNT ST. HELENS MICROPROBE ANALYSIS OF GLASS SHARDS FROM THREE LOCALITIES

	SiO ₂	Al ₂ O ₃	TiO ₂	CaO	Na ₂ O	K ₂ O	MnO	MgO	FeO
Kellogg, ID	71.0±1.4	15.5±.2	0.43±.08	2.53±.12	3.92±.27	2.09±.10	0.05±.03	0.93±.14	2.48±.26
Odessa, WA	71.6±2.6	15.8±.5	0.39±.07	2.64±.27	3.87±.30	2.03±.10	0.05±.02	0.94±.13	2.45±.13
Moscow, ID	72.0±1.3	15.4±.4	0.41±.06	2.48±.22	4.08±.18	2.09±.18	0.05±.03	0.95±.12	2.46±.17
Average	71.7±1.6	15.5±.4	0.42±.07	2.53±.23	3.93±.26	2.05±.14	0.05±.03	0.95±.13	2.47±.18

holocaust. Shock waves from the blast did as much damage as the sliding and falling debris. Seventeen miles from the mountain, 150-foot Douglas firs were uprooted and scorched by the searing heat. Some 45,000 acres of fir forests were levelled in a gigantic blowdown unparalleled in any previous volcanic record. Boiling mud flows, fluidized by volcanic heat, melting glacial ice and ground water, swiftly overflowed reservoirs, swept away or buried homes, ripped out bridges and killed salmon and trout by the millions. Some waters were so hot that fish flipped onto the banks in an effort to escape.

To the west, the Toutle River's main and south forks became clogged with debris from the melting ice mixed with ash, logs and soil, as did Pine Creek and Muddy River, tributaries draining the mountain's east flank and feeding into Swift Reservoir. Mudflow debris choked that reservoir for a half mile out from its previous inlet. So much debris passed down the Toutle into the Cowlitz River to spill into the Columbia River near Longview that a passage normally 600 feet wide and 40 feet deep shallowed to 14 feet and 200 feet wide, preventing ocean-going ships at Portland, Oregon and Vancouver, Washington from sailing down-river until heavy dredging was accomplished weeks later. Motorists, too, were stranded for up to three days on 6000 miles of "disabled" roads in eastern Washington and Idaho where cars (and aircraft) found difficulty in operating in the dust because of clogged carburetors. This most ancient of geologic processes had brought to a halt much of the complex daily activity and logistics of modern civilization in the region.

More than volcanic ejecta and air blasts of searing heat affected the land. In addition to the deep tragedy of sixty-one lives lost, several billion dollars in material damage was incurred, the effects of which will be felt for decades. There was also a psychological effect from the destruction of the once beautiful mountain that I had come to know through a number of ascents in my youth. Those of us who are mountaineers in the northwest feel that we have lost an old friend.

I was particularly stunned for it was on Mount St. Helens, about 60 miles from my home in Tacoma, that I first learned to climb and ski back in the 30s. Two years ago, a group of us tried to climb it again . . . "for old time's sake" . . . but were turned back by wind, rain and fog. I'm sorry we lost out on that last chance. I remember how fresh and warm the ground seemed as we started the aborted hike in the fog above Spirit Lake. Now it seems almost prophetic. One of my climbing partners, Wayne Smith, a physician from Chehalis, was carrying replacement thermometers for a weather shelter he had placed on the summit in one of his 60 ascents of the peak in recent years.

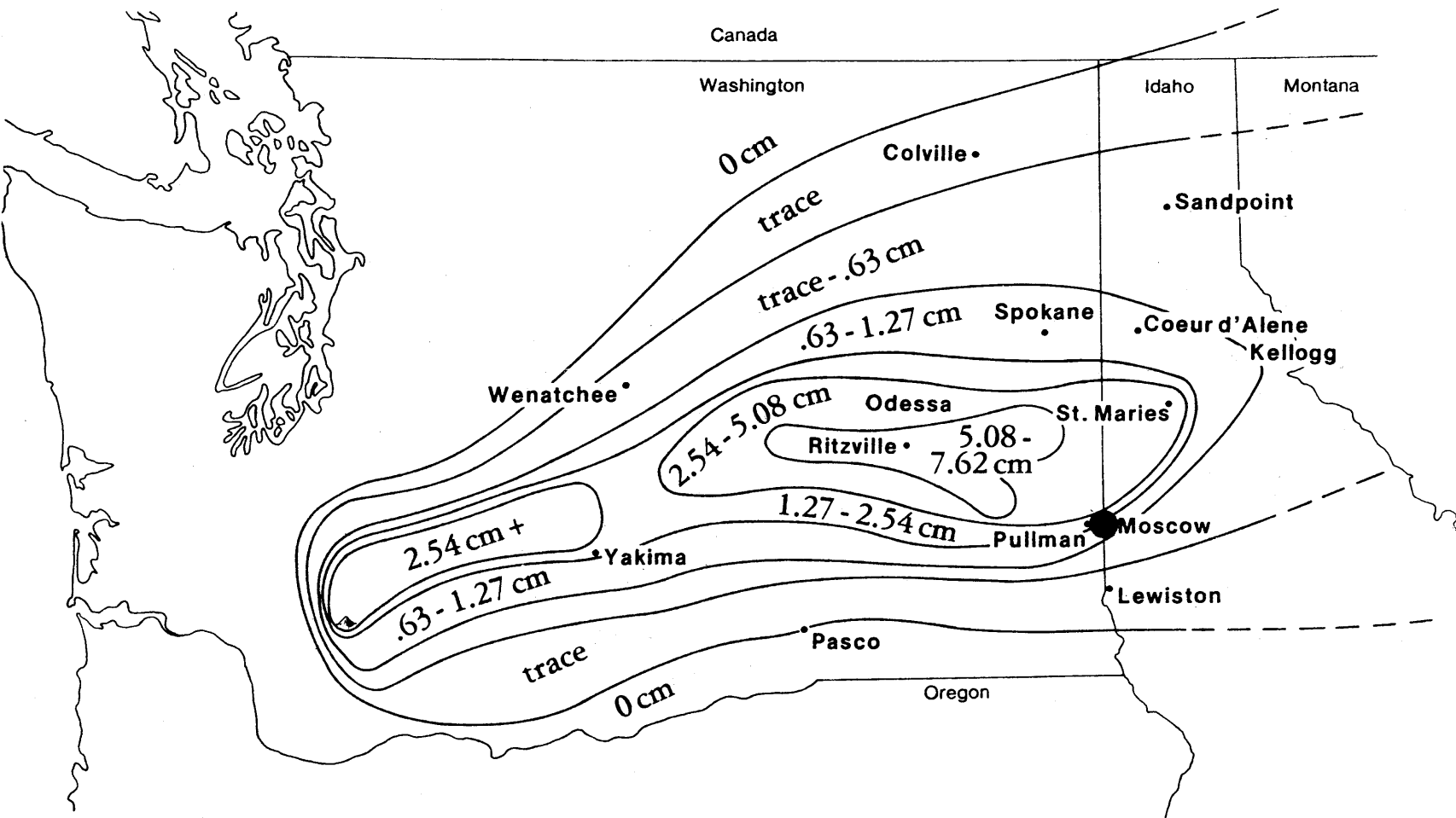
The nation too was numbed, humbled and awed by the press reports and photographs. Perhaps nothing had so commanded public attention since man's landing on the moon. But paradoxically, as a scientist I was excited, for this was a geological phenomenon unparalleled in my life-

time. The mountain's dormancy since the 1850's has obscured its earlier violent nature and so has added to the impact of the event on the public's mind. But from the geological view, the eruption was not unusual, being only one of many in recent geologic time. Records reveal an eruption almost as large in 1500, as well as lava and pyroclastic flows and much ash between 100 and 350 A.D. Before that there was a cataclysmic eruption four times as great in 1900 B.C. (Vesuvius in 790 A.D. ejected three times as much material and in 1912 Katmai expelled 12 times as much debris.)

An excellent history of the mountain's earlier volcanic history is given by Dwight R. Crandell and Donald R. Mullineaux in *U.S. Geological Survey Bulletin 1383-C*, published in 1978. This report also considers questions of geologic hazards from future eruptions and predicted a major outburst before the end of the century. Geologists studying the phenomenon are convinced that this mountain will be rebuilt by ongoing natural forces, because it has been the site of so much activity over the past 30 to 40 centuries . . . at least one major eruption every 500 years in the past 36,000 years. These are paled, however, by the gigantic blow-up in 4600 B.C. of another Cascade volcano, Mount Mazama, situated at Crater Lake, Oregon. That eruption produced 46 times more ejecta than the 1980 Mount St. Helens event and deposited upwards of 20 feet of ash within 100 miles of the vent, even throwing cobble-sized rocks as far northeast as the Province of Alberta.

As we look back over the history of Mount St. Helens, it is of interest to note the legend of the Cowlitz Indians that depicts this mountain as Loo-wit, a beautiful Indian princess who, to insure peace in the tribe, had been turned into this graceful mountain after her suitors warred to the death to woo her hand. Was this legend born out of the cataclysm of 1500? A span of 26 years of eruptions was reported between 1831 and 1857 after which the princess lay dormant.

On March 27, 1980, a new crater opened on the mountain. Dirty steam and ash stained the white snow of spring, the first outward sign of rebirth of the volcano. This was one week after a series of unusual seismic events were observed and believed to herald new lava movements at depth. On through April and early May there were continued earth tremors of increasing magnitude, with clouds of ash and steam . . . some rising to 18,000 feet . . . emitted over a few seconds to a few hours at a time. White clouds meant phreatic water, steam resulting from the heating of downward percolating ground water. Darker clouds involved explosive bursts of solid material, actually pulverized clasts of rock (tephra). Increasingly, slides and avalanches occurred with ash-laden snow pouring down the slopes, as chocolate syrup off the sides of an ice cream sundae. Then the crater periodically heaved, seethed and erupted, deepening to 800 feet and further cracking in its inner wall with more material sliding down.



Ash Thickness Distribution May 18, 1980

Just before the big event, great cracks formed on the north side near the dominant rock outcrops known as Dog's Head and the Goat Rocks, with the crater dropping graben-like even deeper into the mountain. This was followed by surface swelling of about five feet per day on the north side, as recorded by U.S. Geological Survey helicopter crews monitoring emplaced tilt meters and conducting precise laser distance measurements. By April 10, the upper flank had bulged out by more than 320 feet. (The scientists referred to this as the Forsyth Bulge, as it paralleled the Forsyth Glacier—see photos). Accompanying this was further cracking and inward flow of melt-water with such steam generation from dissipated ice and snow. We now realize that the warnings were clear, because the entire side of the mountain was easing northward, with more cracks forming and ground temperatures increasing.

On the seismographs, dramatically jagged lines of normal earthquakes gave way to smooth lines of the harmonic tremor, produced by the rising of lava from depth. During the last week of April, an average of 33 quakes were reported per day. This brought more mountain watchers to the peak and made Washington's Governor proclaim a "red zone," limiting access to within ten miles of the mountain and forbidding all non-scientific visitors to come any closer.

A few individuals sneaked to the summit and peered into the hissing crater, to return and blatantly report their reckless ventures to a press eager for information on the unfolding drama. The activity brought Dr. David Johnston to his Coldwater Ridge observation post, along with Reid Blackburn of the *Vancouver Columbian*, hired by the National Geographic Society to set up radio-triggered cameras and to take photos for the U.S. Geological Survey. Blackburn took up a position three miles west of Johnston's site, both locations within the soon-to-be-devastated zone.

On May 17 it had brought Jim Fitzgerald with permission to do volcanological field work in the vicinity of Spirit Lake. He was to be joined there the following morning at eight A.M. by two geology students from neighboring Washington State University. Their lives were spared at 8:32 A.M. because they were late, still 10 miles from the rendezvous point. Turning their car, they sped away at 90 mph as they watched the edge of the billowing cloud approach. Had they been in the center line of the 200 mph blast, they would not have made it during those few seconds when the mountain literally tore herself apart. At the same time, other observers turned and fled . . . but, as we know, not all were so lucky.

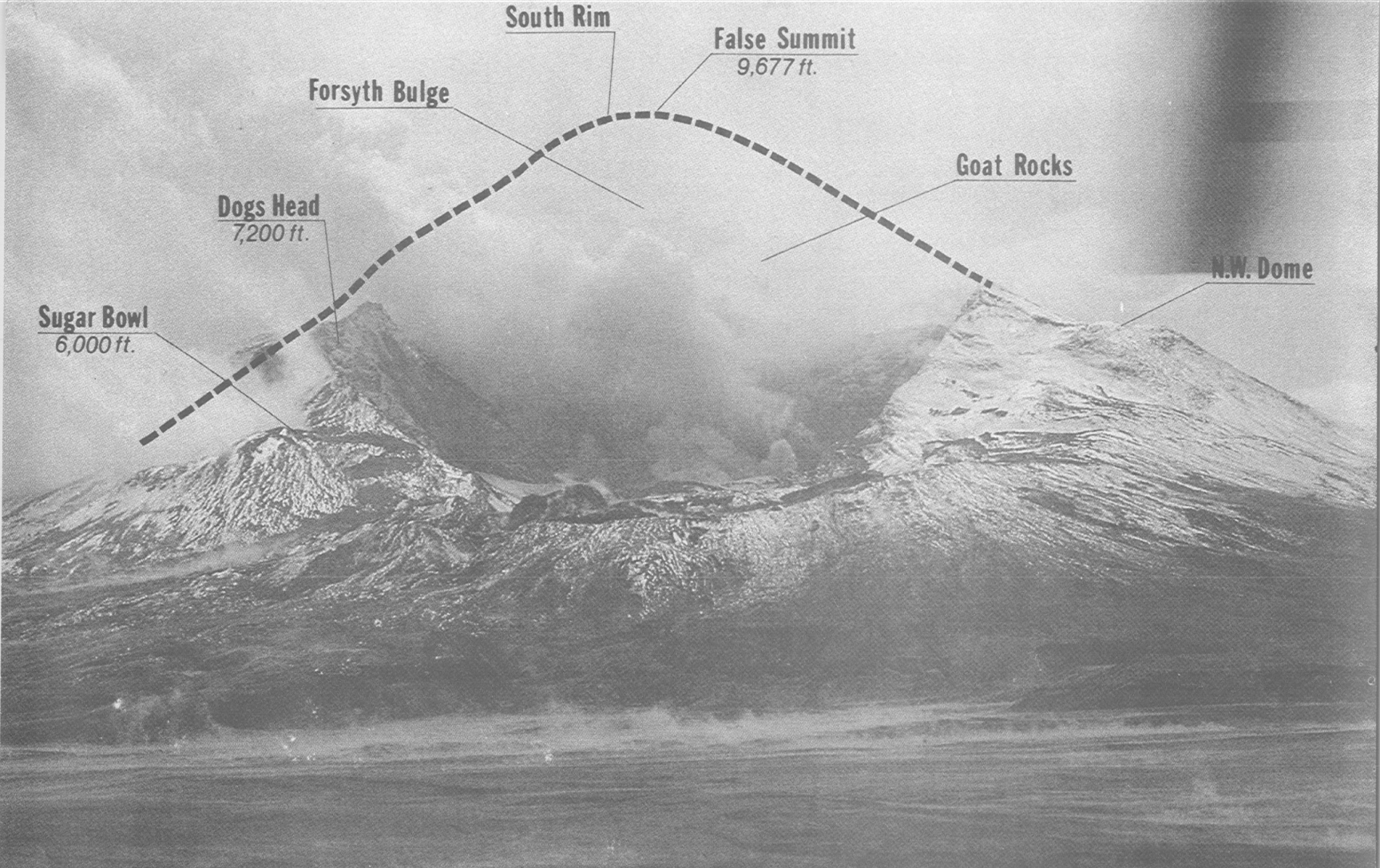
Mount St. Helens is categorized as a "stratovolcano," comprised of alternating conical layers of lava, pumice and ash, piled on top of each other and laid down on its flanks by successive ancient eruptions from a single center. Because these layers seal internal pressures more effectively, stratovolcanoes are more dangerous than the "shield" volcanoes of the

Hawaiian Islands, which are broader and more gentle in configuration, being the result of outpoured pyroclastics and flow material from a number of sources, including elongated fissures. The eruption of Mount St. Helens is considered to be of the classic Peléean type of stratovolcanic eruption, such as that at Mont Pelée on the Island of Martinique. In 1902, this mountain erupted explosively, killing 30,000 persons in the nearby town of Saint Pierre. Pelée eruptions are the most violent type, with vast quantities of pumice ejected at high velocity because of concentrations of volatile gasses trapped in the central magma chamber. This is also the kind that characterized the 1951 eruption of Mount Lamington in New Guinea and of Bezmyannaya in Kamchatka in 1957, mountains at far points in the so-called Pacific Ring of fire.

We now believe that Mount St. Helens and the other young volcanoes in the Cascade Range are the result of submergence of the Juan de Fuca plate, a basaltic ocean floor segment rimming the shore from northern California to off the coast of west central British Columbia. This plate is being subducted beneath the continental North American plate at a rate of about an inch per year. During this process, it melts into magma that rises through fractures in the lithospheric crust, perhaps from depths as far down as 40 to 60 miles.

Although in the devastated zone, fireweed, lupine and a few trees are beginning to grow again, a forlorn landscape remains that will take decades to revegetate. On the mountain itself, where once a proud crestal dome stood, is a hole over two miles long, one-and-a-half miles wide and 2100 feet deep. It is surrounded by crater walls on three sides, giving it the appearance of a giant hollowed molar. With the old summit gone, the present high point lies on the south side of the rim, at only 8364 feet (2549 meters) in elevation, instead of the 9677 feet it boasted prior to May 18. By removal of nearly the cubic mile of ejected material, the peak has been reduced from the fifth largest in the state to thirtieth in the hierarchy of peaks.

We suspect that Mount St. Helens may be entering a self-regulatory phase comparable to that in the early middle of the last century. As such it will probably continue to bubble and brew for some decades. Because the "plug" has been removed, it probably will not erupt violently for another half millenia. In the meantime, it will fill its new crater with lava until a new dome is built, perhaps even higher than before. As for her neighbors, Mount Rainier was last active about 150 years ago, but its two summit craters are still hot. This could result in further mudflows down her flanks. Mount Baker (10,770 feet, 3,285 meters) breathed ash and steam briefly during 1975, but appears quiescent now, although it too has much retained heat at depth. Mount Adams, Glacier Peak (10,541 feet, 3213 meters) and Mount Hood (11,235 feet, 3424 meters) have been less active but also remain warm in their central craters where renewed activity could set mudflows in motion causing local damage.



South Rim

False Summit

9,677 ft.

Forsyth Bulge

Dogs Head

7,200 ft.

Sugar Bowl

6,000 ft.

Goat Rocks

N.W. Dome

Alarminglly, Mount Hood in Oregon was the center of more than 50 small earthquakes last July. Because these other Cascade volcanoes are older and more truncated by erosion, they appear less dangerous. We hope this is so, but all of them bear scientific watching.

Mount St. Helens will no longer attract climbers with purely mountaineering aims, for it is an ugly place now. It will attract a new cadre of tourists, however, and to its heights mountain-minded people with scientific interests will climb. Although the peak has lost its majesty and gentle high beauty, it will soon be designated as part of a national volcanic park, to keep us mindful of nature's power and the need through science, research and experience to understand her self-regulatory processes which, when viewed over short periods of time, can seem so capricious.

Perhaps the greatest lesson is that man cannot control these awesome long-range forces. We can only control our reaction to them and our manner of adapting to them.

EPILOGUE

What has happened since May 18th?

One week after the first eruption, on May 25, another major eruption took place at 1:32 P.M. with an ash-rich plume rising to 50,000 feet and spreading a thin layer of ash 100 miles to the northwest, as far as Grays Harbor on the Washington coast. Within the crater, this was accompanied by development of a wall-like ridge of pumice. Thermal infrared images on June 8 showed a new build-up of heat in the old eruptive center. Another explosive eruption on June 12 resulted in more pumice which flowed down into the Toutle Valley. Thereafter, a lava dome began to build in the crater, reaching a height of 120 feet and a width of 330 feet by June 30. On July 22, four more powerful explosions produced ash plumes to 50,000 feet. As in all of these post-eruption events, SLAR (side-looking radar) imagery has pinpointed eruptive centers inside of the crater, although there is suspicion that there may be some thermal venting at the base of the peak in the north Toutle River Valley.

Since last summer there have been lesser eruptive activities and minor earthquakes, with a small increase in the size of the crater's lava dome. These post-eruption perturbations are probably only the first in a long series of continuing disturbances yet to come. The mountain is not expected to have another major eruption for some time because its confining cap has been blown away. Of one thing we are sure and that is that there is an immense amount of scientific attention continuing to be focussed on the mountain. To date the earth scientists who have so diligently monitored these events and who continue to assess their hazards should be pleased with the results of their efforts.

The warnings, safeguards and precautionary recommendations they provided undoubtedly minimized loss of life prior to and during this great eruption . . . a force comparable to 500 Hiroshima-sized nuclear blasts. The knowledge gained should also be helpful in coping with the next one . . . if and when it comes, either here or in one of the other Cascade peaks.

When will that be? Well, remember, that Mount St. Helens was considered dormant until that afternoon of March 27, 1980.