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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 229 - 5580

FIELD OFFICES
2033 First Street, Baker 97814
521 N. E. "E" Street, Grants Pass 97526

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IF MOUNT HOOD ERUPTS

Paul E. Hammond
Department of Earth Science, Portland State University

Volcanism at several sites around the world in recent years has shown that a number of volcanoes considered "dead" were only dormant and that renewed activity is an ever-present possibility. Many geologists anticipate that within their lifetime one of the sleeping Cascade volcanoes will erupt. After all, Mounts Baker, Rainier, and St. Helens erupted several times in the 1800's, Mount Lassen in the early 1900's, and today Mount Rainier, Mount St. Helens, Mount Adams, and Mount Hood have active fumaroles and hot spots.

Every year more people move toward the foothills and slopes of the Cascade Mountains for summer and winter recreation, or they migrate up the stream valleys that lead toward the mountains to occupy seasonal or permanent homes. An eruption of one of the dormant volcanoes could endanger the lives of thousands of these people.

Dr. Paul E. Hammond, author of this imaginary story, is a geologist and an authority on the Cascade Range and its volcanoes. His vivid interpretation of what might happen if Mount Hood should erupt is based on his intimate knowledge of volcanic processes and the evidence for repeated eruptions in relatively recent time. As well as telling a story, he gives careful thought to ways Oregonians can be prepared to meet the hazards of a volcanic eruption. Ed.

This story was written not by an alarmist but by a geologist with an avid interest in Cascade volcanoes. It is not a story of when Mount Hood will erupt but how it could erupt. Geologists are fully cognizant of the processes of change on earth, from some imperceptibly slow to those which can relentlessly wash out beach homes, to others violently catastrophic such as earthquakes. Processes of change are inevitable. Man cannot stop them, but he can be prepared to meet them. That is the purpose of this story.

A news agency article in the Oregonian, April 22, relates that on April 21 a small earthquake, magnitude 3.8, occurred near Mount Hood. Seismologists at Oregon State University are quoted as saying the quake occurred at 10:43 a.m. PST, lat 45°27' N., long 121°37.5' W., near the northeastern base of Mount Hood, at a focal depth of about 40 km.

On May 4 another communication reports a quake at 2:10 p.m. PST, magnitude 3.2, at lat 45°24.0' N., long 121°53' W., north of Rhododendron, with a focal depth of about 16 km.

Again an earthquake is reported at 9:18 p.m. PST, May 9, magnitude 2.5, focal depth 10 km, at lat 45°24' N., long 121°47' W., also north of Rhododendron. Residents of upper Hood River and Sandy River valleys are alarmed.

Repetition of earthquakes near Mount Hood, each decreasing in focal depth, indicate that magma may be rising from a source along a conduit leading to the volcano. Volcanologists concur that an eruption of Mount Hood may well be pending. On May 10, personnel at Timberline Lodge report feeling small tremors, rattling of dishes, and the creaking of the structure, which they believe to be the aftershocks of the May 9 quake. Observers of the mountain report seeing light-colored clouds, either as steam or dust, rising from the snow-clad summit. The State Emergency Services Division, Salem, after consultation with the U.S. Geological Survey, the State Geologist, and the center of Volcanology at Eugene, requests daily air observation of the peak.

In the morning of May 11, after the first flight, aerial observers report no unusual features on the mountain top. Visitors at Timberline Lodge report an increasing number of tremors, most of which are felt as "rolls." The Governor's Office, Salem, calls for a Volcano Alert of all Cascade volcanoes, with particular attention to Mount Hood.

On May 12, after the second morning's flight, in which infrared photographs are taken, there is no report of a visible change in Mount Hood from the previous day. Observers at Timberline Lodge, with clear sky as background, report seeing well-defined steam plumes rising from the Crater Rock area at the summit. Microseismic activity continues; the number of tremors exceeded 100 on May 11. Plans are made to evacuate Timberline Lodge and Mount Hood Meadows. All guests are requested to leave by noon and most employees to leave by 6:00 p.m. of the next day. The State Police assume patrol of U.S. Highway 26 and Oregon Highway 35. Hood River and Clackamas County Sheriffs' offices establish a Volcano Watch in cooperation with the State Emergency Services Division. A 24-hour watch is set up at Multorpor Lodge, near Government Camp, and on Middle Mountain in the upper Hood River Valley. The State Office also requests 10- and 20-day meteorological forecasting in the event of extensive volcanic ash eruptions, which are typical of the Cascade peaks.

Although clouds enshroud the peak all day, precluding any observations of steam activity, the third set of infrared aerial photographs, taken

in the early morning hours of May 13, shows increased thermal activity at the fumaroles around Crater Rock. Microseismic activity continues at about the same rate as the previous day. Staff members remaining at Timberline Lodge report two sharp quakes, one at 10:37 p.m. and the other at 11:15 p.m. Strong winds and heavy rains have obscured the peak since mid-day.

In the morning of May 14, adverse weather prevents infrared aerial photography of the peak. United Air Lines flight 482 bound for Portland from San Francisco reports seeing a dark billowy cloudmass among storm clouds in the vicinity of Mount Hood at 9:12 a.m. At the same time, the skeleton staffs remaining at Timberline and Mount Hood Meadows report continuing tremors and an unusually dark cloud amidst the storm. The rain is muddy! They are advised to leave immediately. Thereafter the Timberline road is closed to general traffic. A 10:00 a.m. surveillance flight by the volcano watch crew reports seeing a low dark ash cloud over Mount Hood, confirming earlier reports. The State Police immediately set up check points on U.S. Highway 26 and Oregon Highway 35, warning motorists. State offices at Salem and Portland and the news agencies issue periodic radio warnings and advise on conditions. County Sheriff offices warn residents in the valley bottoms at the foot of Mount Hood as far west as Brightwood to prepare to evacuate at a given radio signal.

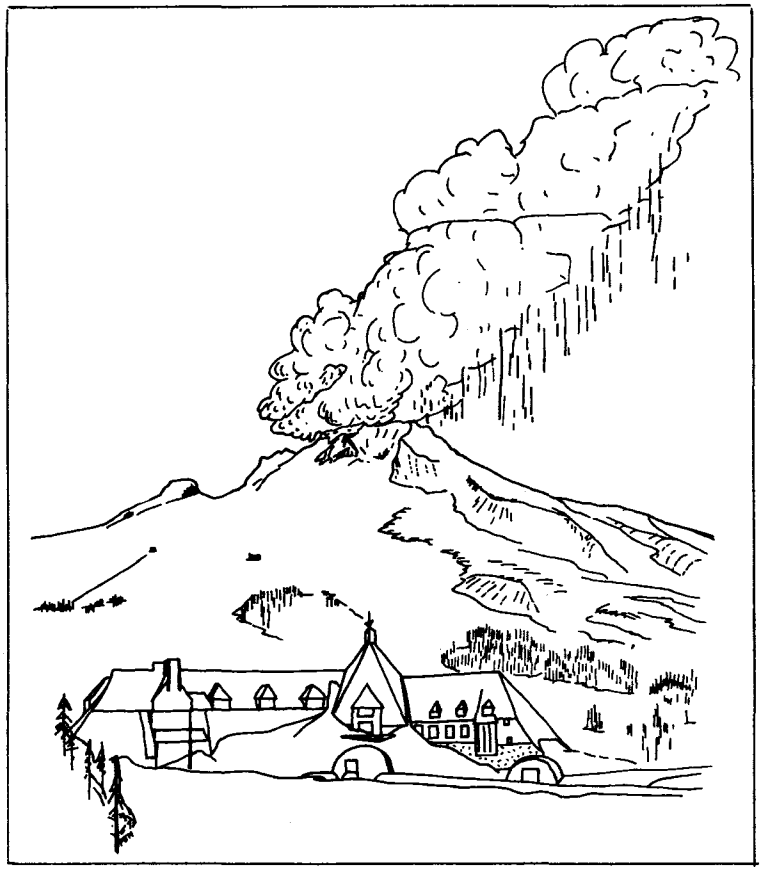
The storm continues unabated all day, obscuring efforts to see the shape and size of the ash cloud and exact position of the erupting vent.

Aerial surveillance that afternoon reports that a large dark cloud of ash is rising to about 17,000 feet altitude to the northeast from Mount Hood. The sheriff of Hood River County reports that evening that about a quarter of an inch of fine mud is accumulating on county roads. Ash is also reported to be falling on Interstate Highway 80N in the Gorge between Hood River and The Dalles. Another report that night, made after completion of an aerial surveillance for infrared photography, indicates that a greatly enlarged "hot spot" is centered about 1,000 feet west of the summit of Mount Hood and north of Crater Rock at an elevation of about 10,500 feet. Fearing the worst, the State Police close U.S. Highway 26 between Cherryville and Wapinitia Junction and Oregon Highway 35 south of Parkdale at 11:00 p.m., and residents are warned to be prepared to evacuate.

River watchers, assigned to the forks of the Hood, White, Zigzag, and Salmon Rivers, report during the night that waters are rising as expected after the two days of heavy rain and moderating temperatures. The waters are colored gray by the admixture of ash. The volcano watchers at Multorpor telephone that no glow is visible at night but audible booms of the eruption can be heard above the diminishing wind.

Dawn flights on May 15 reveal a giant pluming dark-gray cloud rising rapidly above Mount Hood to about 25,000 feet altitude and trailing northeastward in a broad dark band about 60 miles.

Observations continue. At 11:00 a.m. Mount Hood is emitting a



Sketch of Timberline Lodge showing how Mount Hood might look during the eruption. Billowy cloud of ash trails to the northeast on the prevailing wind.

steadily increasing volume of ash. The size and elevation of the ash cloud is increasing and accompanied by sporadic lightning. The sound of the explosive eruptions is intensifying. There is now the possibility of large mudflows originating on the slopes of the volcano, in view of the magnitude of the eruption and melting of the glaciers and snowpack. All people in the valleys are warned to leave immediately in anticipation of these mudflows. Those communities affected are in the Hood River valley, along the Zigzag, Salmon, and Sandy Rivers downstream to Cherryville, and along the White River valley to Tygh Valley. Residents on the lower Sandy River, including Troutdale, as well as those in Hood River, are warned of the possibility of mudflows.

At 12:00 noon, Timberline road is reported impassible to motorized wheeled travel; up to six inches of gray ash and small rocks cover the road. The State Police warn motorists on Interstate 80N between Cascade Locks

and Biggs Junction of obscured visibility and recommend only essential traffic be permitted. The Wasco County Sheriff at The Dalles reports that the ash fall there is 3 inches deep, exceeding the deposits of the Mount St. Helens eruption of 1842.

At 2:00 p.m. reports indicate that river waters continue to rise steadily; their particle content has increased substantially. The stream flow in the upper Hood River is reported to resemble a slurry and there is flooding locally. Explosive eruptions are increasing in volume and tumult. The ash fall appears to contain a greater pumice and rock content than initially. Up to six inches of ash reportedly cover stretches of Oregon Highway 35 in the upper Hood River Valley. State Emergency Services Division declares that mudflows are imminent and calls for evacuation of all threatened low-lying areas. Remining residents and personnel at Government Camp and Parkdale are ordered to evacuate. At 4:00 p.m. the State Police close U.S. Highway 26 at Sandy and Oregon Highway 35 south of Hood River. The ash is clogging air intakes on the State Highway vehicles, causing frequent breakdowns and thereby preventing police from clearing the highway.

At 8:00 p.m. aerial surveillance reports that the ash cloud has risen to 47,000 feet altitude and extends eastward about 150 miles. The State Police warn motorists on I-80N of greatly obscured visibility between The Dalles and Pendleton; all vehicles must be driven with lights on.

During the night the volcano watchers report a vivid glow at the vent. In addition, there are noted increased intensity of explosions and strong microseismic activity, exceeding the activity prior to the eruption. Watchers along Hood and Sandy Rivers report increased flooding by muddy water - the Sandy downstream from Wemme, the Zigzag River above Rhododendron, and the East Fork of Hood River above Parkdale.

In the pre-dawn hours of May 16 the watchers report that at least four glowing balls of fire, accompanying strong explosions, rose from the vent, perhaps signifying the degassing stage of the eruptive cycle. Aerial flights, which continue to monitor the activity, report at dawn that the ash cloud column now rises to at least 72,000 feet altitude and extends eastward about 250 miles and north-south about 80 miles as a tabular blanket. Although the observers are not able to fly into the dense clouds, they note through breaks in the clouds that the landscape on the eastern slopes of the volcano is barren. A black carpet covers the terrain. Trees are either defoliated or bowed under the weight of the moist ash. The lodges at Timberline and Mount Hood Meadows are mantled by an estimated 6 inches of ash on top of snow. A lava flow is seen advancing slowly down the west flank of Mount Hood onto the Reid Glacier in the upper headwaters of the Sandy River. Sizable mudflows can be expected to descend the Sandy River valley within hours. By 7:00 a.m. Sheriff's patrols are ordering residents in the lower Sandy River valley near Troutdale to leave.

At 9:00 a.m. the Portland Water Bureau reports that very fine volcanic ash is entering the drinking water system on Bull Run River and

discoloring the water. Bonneville Power Administration reports that The Dalles dam has trimmed the flow through the turbines in order to prevent corrosion by ash-laden waters. Restricted use of electrical power may be required. Portland General Electric reports that a power line is down near Lolo Pass on the northwest side of Mount Hood, probably due to the weight of accumulated mud-caked ash. The U.S. Geological Survey, Washington, D. C. releases to the news media the communication that a major volcanic eruption is underway at Mount Hood, Oregon, located 50 miles east of Portland. This is the second eruption in the Cascade Range in this century, the first being the 1912-17 activity at Mount Lassen in northern California.

At 11:00 a.m. the Governor, from his temporary office in Portland, declares a state of emergency in Clackamas and Hood River Counties and requests emergency funds from the President to (1) maintain radio communication in the disaster area and coordinate surveillance by military helicopter flights; (2) provide temporary food and housing for evacuated citizens, reportedly about 5,000; and (3) augment the efforts of the Highway Division, State Police, and County Sheriffs' offices to rescue persons trapped by the accumulating ash and to clear some highways as soon as possible.

Public officials now feel that water and power supplies to Portland are imperiled. There is considerable concern about the possibility of a shift in the upper atmospheric wind pattern which could bring the ash cloud toward Portland. Reportedly the Governor of Washington and officials of Vancouver and Clark County are keenly watching developments.

At noon the State Highway Division closes I-80N between Hood River and Pendleton and U.S. Highways 197 and 97 between I-80N and Madras to non-commercial traffic because of extremely poor visibility, in places reduced to less than a quarter of a mile.

At 2:00 p.m. the Bonneville Power Administration halts power output at Bonneville, The Dalles, and McNary dams because of the high ash content in the Columbia River water. Industries in northwestern Oregon and southwestern Washington are to cut their power consumption to just 10 percent. Many industries are reportedly closing temporarily. Households in the Portland-Vancouver area are asked to limit power consumption. Portland Water Bureau warns citizens to store water - fill bathtubs, washing machines, bottles, etc. - in the event the Bull Run water supply is shut off or impaired. The tap water has become increasingly cloudy, producing a "run on the market" for bottled distilled water. The City Council is considering temporarily closing the Bull Run water supply and seeking alternative sources from the Willamette River, upstream from its confluence with the Clackamas. Fortunately Portland's water supply is not nested on the flank of Mount Hood, where the facilities could be devastated by mudflows or lava flows.

At 4:00 p.m. the helicopter observer, dispatched just minutes before to survey the western slope of the volcano, reports that the snout of the lava flow has descended to the middle portion of the Reid Glacier, and

large incandescent blocks are dropping from the lava front down the icefall on the glacier between the 7,500- and 8,000-foot elevations. As he is radioing his report, a huge mass of snow and ice suddenly projects outward from the icefall, carrying with it most of the lava flow, and surges down the steep slope to the Sandy River. A churning mass of ice blocks, rocks, and broken trees descends the river in less than 5 minutes, bursts from the narrow defile near Ramona Falls as a wall 500 feet high, and spreads across the valley floor above Old Maid Flat. Trees are severed at mid-heights, debranched, and uprooted in one sweeping movement. The mudflow slams into the southeastern base of Last Chance Mountain and surges up the mountainside almost 800 feet, sweeping it clean of trees. Continuing down-valley the flow surmounts Cape Horn and moves relentlessly onward, the velocity and height of the front decreasing, due in part to the huge, wildly flailing matchstick-like mass of entwined trees in front. In twenty minutes the mudflow reaches Zigzag River, its front less than 100 feet high. The flow quickly spreads out, part surging up the Zigzag River into Faubion and Zigzag. A large mass flows over the Sandy River bank just upstream of Wemme, overwhelms the town, and continues across the terrace separating the Salmon and Sandy Rivers. Part of the mudflow is dissipated in the timber atop the terrace, but two streams continue down-valley, joining at Brightwood about 20 minutes later into a single mass 50 feet high. The flow widens, thins, and slows considerably in the broad valley below Brightwood. It flows over the diversion dam near Cherryville and surges almost to the top of the terrace at Roslyn Lake. From there down-valley the mudflow is confined to the steeper canyon walls of the Sandy River. Forty minutes later the Sheriff reports the flow passing Dodge Park; its front is now only 20 feet high, and it clears the three water pipes from Bull Run to Portland.

Minutes after helicopter surveillance reports the collapse of Reid Glacier all bridges across the Sandy River are barricaded in anticipation of the surging wave of debris which may ram the bridges aside. The bridge on Highway I-80N is no exception. In the almost two hours since the mudflow began, hundreds of spectators crowd the high banks of the Sandy River near Troutdale to await its arrival. Fifty minutes later the flow front, a 10-foot wall of foam, debris and mud, passes beneath the Crown Point highway bridge and a minute later beneath the I-80N bridge.

By dusk May 16 observers note the mudflow has deposited a sheet of dark-gray mud, sand, and boulders more than 100 feet into the Columbia River beyond the mouth of the Sandy River; the Columbia River is carrying a gray streak along its south shore downstream to the Interstate Bridge. The level of the mudflow has subsided but considerable fresh debris lines the banks, and rafts of branches and bark float in the dark water of the Sandy River. By now the State Highway Division and State Police, in communication with volcano observers and the State Emergency Services office at Portland, consider that the mudflow and the surging flows in the aftermath of the main mass are abating and I-80N can be reopened to traffic to Hood River.

The last May 16 daylight observance by helicopter of the vent area on Mount Hood seems to indicate that the rate of lava outpouring is increasing and that fresh lava is steadily flowing into the void created by the melted Reid Glacier. Returning to Troutdale airfield over the Sandy River valley the observer reports that the valley is now a swath in which streams are winding among boulders and mud. Vast numbers of trees and debris of smashed houses and bridges, pushed to the edge of the swath, now lie tens of feet above the muddy water's surface.

Several volcano observers, including the Clackamas County Sheriff, note that the ash cloud above the volcano has diminished both in height and density. The explosive activity is also lessening. During the night a bright glow can be seen near the summit and a narrow ribbon of lava streams westward downslope from the spot.

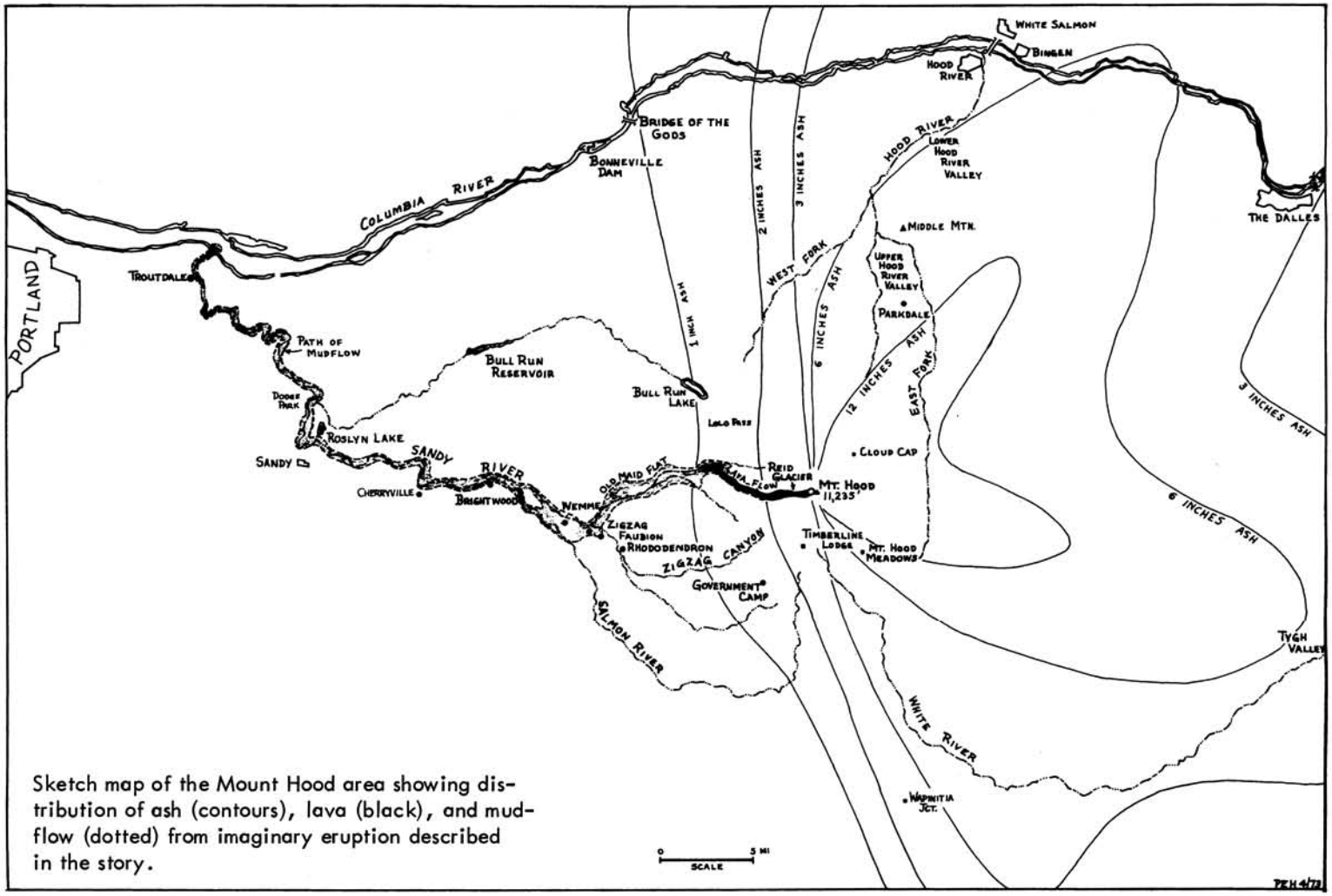
By mid-morning May 17 it is obvious that the amount of ash fall from the volcano is greatly reduced. Reports from The Dalles and points east on I-80N indicate improved visibility, and the State Police are permitting normal traffic flow. Snow plows are assigned to remove drifted ash.

With favorable reports coming in, the State Emergency Services Division personnel in Portland begin to relax. The Portland Water Bureau believes the Bull Run water supply may survive but the water in the reservoirs will be murky for a year until after the next years' runoff. Bonneville Power Administration announces that reduced power output will continue for at least another five days. No power is being generated at the lower Columbia dams. There is hope that if the eruption is diminishing, the ash being carried into the Columbia by Mill Creek and other creeks near The Dalles and by the Hood and Deschutes Rivers will decrease substantially within the next 5 days and settle in the Columbia River reservoirs, provided a heavy rain storm does not strike on the heels of the eruption.

The major fear now is that (1) a meteorologic storm could cause a number of devastating mudflows in all valleys around the volcano; and (2) volcanic activity could be renewed, with new ash and lava eruptions; and as a remote possibility, (3) the lava flow might extend to Zigzag and form a barrier across U.S. Highway 26.

A check of Portland hotel and motel facilities by the newspapers indicates that most are booked solid by sightseers, many of them Californians, and a lesser number of Seattleites, to witness the eruption and follow its activity. Fortunately the State Police have closed U.S. Highway 26 at Sandy to prevent sightseers from interfering with the rescue operations to restore communications and travel within the devastated Sandy River valley.

Assessment of the damage of the Sandy River mudflow and the eastward ash-fall are now being reported to the Governor's office and released to the news services. At least $9 million damage has occurred along the Sandy and Zigzag River valleys; bridges between Dodge Park and Zigzag have been smashed or lifted from their foundations. In addition, buildings along the valley floor between Alder Creek and Zigzag have been destroyed



Sketch map of the Mount Hood area showing distribution of ash (contours), lava (black), and mudflow (dotted) from imaginary eruption described in the story.

or extensively damaged. Fortunately the wind has blown nearly constantly eastward during the eruption and has carried the ash away from the orchards of Hood River valley, although some severe leaf and bud damage is reported to trees in the upper valley. Damage to timber and logging operations in the area east of Hood River is not considered to be extensive.

Throughout the entire eruption, up to 4:00 p.m. May 17, not one death has been reported. Thanks to the speedy efforts of the State Emergency Services Division, the Sheriffs, and the State Police, and the immediate establishment of observers in constant radio communication from vantage points and from the air, residents and motorists have been forewarned and prepared for evacuation. Most fortunately, the volcano this time underwent a gradual buildup of activity, allowing time for nearby persons to evacuate.

May 26: The eruption of Mount Hood has continued for eight more days but is subsiding. This afternoon's helicopter surveillance reports that no lava can be seen issuing from the vent, that the vent is only smoking, and that there is no longer a glow within it. The lava flow has reached the upper part of the Old Maid Flat in the upper Sandy River valley and is cooling and congealing rapidly on the surface.

May 27: The State Police, Sheriffs' deputies, and employees reach Timberline Lodge and Mount Hood Meadows from the south and begin the dusty job of shovelling and bulldozing aside nearly 6 inches of ash and pumice, cleaning out pipes, and airing the rooms.

Portlanders are thankful that this century's eruption of Mount Hood was relatively mild, not nearly as catastrophic as the past eruptions of Mount Mazama and other Cascade volcanoes.

Addendum

Any similarity to dates, times, places, and persons in this story is purely coincidental. Mount Hood did not erupt but it will probably erupt sometime in the future, and the eruptive episode may be similar to the story. Preliminary observations of the volcanic deposits in the neighborhood of Mount Hood reveal that in times past mudflows larger and thicker than the one described have descended Sandy River as well as Hood and White Rivers.* And a large thick avalanche deposit, representative of one of the most recent events at Mount Hood, blankets the southwestern flank of the mountain from Crater Rock to Multorpor Mountain.

As stated in the first paragraph, mankind cannot stop geologic processes, but man can be prepared for a catastrophe.

* * * * *

* Wise, W. S., 1968, Geology of the Mount Hood volcano, in Andesite Conference Guidebook: Oregon Dept. of Geol. and Mineral Indus. Bull. 62, p. 81-98.

GEOTHERMAL AND PETROLEUM DRILLING REGULATIONS EXPANDED

In an effort to accelerate exploration for geothermal and petroleum resources and, at the same time, minimize hazards to the environment, an agreement between the Department of Geology and Mineral Industries and the Department of Environmental Quality is published below. In essence, the agreement spells out the DEQ restrictions on the drilling of wells; these regulations now become part of the permit-to-drill issued by the Department of Geology and Mineral Industries. It is hoped that the agreement will simplify procedures and avoid duplication for those applying for permits.

1. If geothermal activity of commercial interest is discovered, no drilling of additional wells or operations in connection therewith shall commence until an Environmental Impact Statement has been prepared for utilizing and developing the resource.

2. Prior to commencement of any construction or drilling activities, detailed plans and specifications shall be submitted to and approved by the Department of Environmental Quality for collection and disposal of drill cuttings and mud, and other potential waste materials.

3. A contingency plan shall be submitted to the Department of Geology and Mineral Industries prior to any drilling activities outlining the following information and procedures:
   a. Measures taken to prevent emergency conditions or unplanned discharges, such as blowouts.
   b. A description of preventive facilities to contain or treat unplanned discharges.
   c. The reporting system to be used to alert facility management and appropriate legal authorities.
   d. A list of personnel and equipment available to respond to emergency conditions.

4. Upon determination of the Director of the Department of Environmental Quality or the Director of the Department of Geology and Mineral Industries that any activities conducted by the permittee in relation to its drilling operations or activities may tend to or will cause damage, hazards, pollution or risk to the environment of Oregon or may violate any conditions of permits issued by the aforementioned departments, the permittee shall when notified either orally or in writing by the Director of either department immediately cease and desist its drilling operations or activities until the problem has been corrected.

5. All drilling processes and all waste mud and waste waters collection, treatment and disposal facilities shall be operated and maintained at

all times in a manner which will prevent a direct discharge or indirect discharge of any waste mud and waste waters to the waters of the state.

6. All waste mud and waste waters are to be discharged into self-contained, non-overflow holding ponds for which construction plans have been approved by the Department of Environmental Quality.

7. All access roads, trails, drainage systems and the drilling site shall be constructed and maintained to minimize soil disturbances, control erosion and prevent channeling.

8. All refuse shall be disposed of at a refuse site which has a valid permit from the Department of Environmental Quality except as permitted in Condition 9.

9. Nonputrescible combustible wastes such as paper bags and brush may be burned. All open burning must be carried out in compliance with Oregon Administrative Rules Chapter 340, Subdivision 3, OPEN BURNING, Sections 23.005 through 23.020 and all other applicable Federal, state, and local burning regulations.

10. No geothermal waters or other waters or substances which might cause the Water Quality Standards of the State of Oregon to be violated shall be discharged or otherwise allowed to reach any of the waters of the state unless a permit for the discharge has been issued by the Department of Environmental Quality.

11. Sanitary wastes shall be disposed of in chemical or gas-fired toilet facilities which have been installed in accordance with the recommendations of the Oregon State Health Division and the local county health department or by other approved means.

12. In the event a breakdown of equipment or facilities causes a violation of any of the conditions of this permit or results in any unauthorized discharge, the permittee shall:
    a. Immediately take action to stop, contain and clean up the unauthorized discharges and correct the problem.
    b. Immediately notify the Department of Environmental Quality and the Department of Geology and Mineral Industries so that an investigation can be made to evaluate the impact and the corrective actions taken and determine additional action that must be taken.
    c. Submit a detailed written report describing the breakdown, the actual quantity and quality of resulting waste discharges, corrective action taken, steps taken to prevent a recurrence and any other pertinent information.

13. Compliance with these requirements does not relieve the permittee from responsibility to maintain continuous compliance with the conditions of this permit or the resulting liability for failure to comply.

14. Authorized representatives of the Department of Environmental Quality or the Department of Geology and Mineral Industries shall be permitted access to the premises of all facilities owned and operated by the permittee at all reasonable times for the purpose of making inspections, surveys, collecting samples, obtaining data and carrying out other necessary functions related to this permit.

* * * * *

GEOTHERMAL ENERGY POTENTIAL OF DEEP SEDIMENTARY BASINS

As a part of its research to identify energy resources of the United States, the U.S. Geological Survey has undertaken a study of geothermal resources. To date nearly all of these studies have been concentrated in areas of visible thermal manifestations such as volcanoes, hot springs, and fumaroles--the type of areas of the world where geothermal power is currently being utilized. A new dimension has been added to the understanding of geothermal resources by the work of Paul H. Jones, U.S.G.S. hydrologist, who studied the potential for geothermal development of the northern Gulf of Mexico basin. Jones' report, given at the Pisa Symposium on the Development and Utilization of Geothermal Resources in 1970, shows that large areas of the Gulf Coast are underlain by water at temperatures as high as 500°F at pressures as great as 15,000 pounds per square inch. Jones' paper has stimulated more study of geothermal resources in sedimentary basins, and a preliminary report (U.S.G.S. 1972) discussing the geothermal energy potential from this source follows:

> The geothermal energy potential of deep sedimentary basins has been examined by B. F. Grossling (1971). In appraising the long-range prospect of geothermal energy, it is necessary to consider these deep basins because of their large masses of stored water and heat. The total amount of energy that can be recovered without regard to costs can surpass, by way of comparison, the heat of combustion of the oil and gas resources of those basins. The bulk of the waters, however, are low in enthalpy (temperature<150°C), and only a fraction are high in enthalpy (temperature >150°C). The latter may be the more important for electric power generation, depending on costs of drilling, power-generation technology, and other factors.
>
> The size of these high-enthalpy hydrothermal resources in sedimentary basins of the United States hinges on a number of

unresolved questions: (1) Volumes of high-enthalpy waters that may be retrieved by wells, (2) average temperature of these waters, and (3) economics. Porosity, permeability bed thickness, lateral continuity, and other factors determine the amount of water that may be retrieved by wells. These quantities are not well known, especially for the deepest parts of sedimentary basins which may be the most important. The simple projection of near-surface temperature gradients in sedimentary basins, according to Grossling, generally underestimates the temperatures in the deeper parts of the basins where surface gradients are depressed because of subsidence and sedimentation. The economics of the exploitation of the high-enthalpy water would depend on the depth range of the wells, production characteristics of the wells, and the nature of the solids dissolved in the waters.

The sedimentary basins of the conterminous United States have a total area of about 4.9×10^6 km^2, which is about 60 percent of the total area. Moreover, the total sedimentary volume is on the order of 33×10^6 km^3. The maximum depth to basement may be as high as about 18 km. Of the total volume, perhaps about 2.1×10^6 km^3 lies below 4 km depth, and about 30.9×10^6 km^3 lies above it. Assuming that the pore space is filled with water at a mean temperature of 150°C (≈300°F) and that porosity is 5 percent, averaged throughout the total thickness, the total in situ heat of the interstitial water below 4 km is 1.6×10^{22} cal. The considerable magnitude of this total can be appreciated by comparing it with the heat of combustion of 1 million barrels of oil, which is about 1.4×10^{15} cal. That is, the total sensible heat stored in interstitial waters of sedimentary basins of the United States below depths of 4 km may be on the order of the heat of combustion of 10 trillion barrels of oil. The figures for the low-enthalpy waters above 4 km are nearly an order of magnitude greater. The amount of recoverable heat is obtained by multiplying the above in situ figures by a factor which may range as high as 10^{-2} to 10^{-1}. Thus the recoverable amounts are still considerable.

A particularly important objective is finding sedimentary basins with large volumes of interstitial waters in their deep parts, which overlie areas with an abnormally high temperature at the mantle-crust boundary. The Gulf Coast geosyncline and the Imperial Valley - Mexicali Valley area are perhaps the two most important exploration targets in the United States in this respect. For instance, for an area of 100 x 100 km underlain by a layer within the sedimentary column containing permeable beds with an average porosity of 5 percent, a thickness of 1 kilometer, and an average temperature of 250°C, the heat of the water above surface temperature is on the order of 10^{20} cal; this value is equivalent to the

heat of combusion of 90 billion barrels of oil. Thus, even if only a small fraction of the water could be retrieved, still the magnitude of the recoverable energy is considerable.

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U.S. Geological Survey, 1972, Geological Survey research, 1972: U.S. G.S. Prof. Paper 800A, p. A10-A11.

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GULF OIL PLANS OREGON GEOTHERMAL DRILLING

Gulf Oil Company filed applications with the Department for permits to drill two deep exploration holes for geothermal resources in Lake and Klamath Counites. One hole is proposed to be drilled 6 miles northeast of Klamath Falls and the other deep test is to be drilled 2 miles northwest of Lakeview. Hot water and steam occur at several locations in both of these areas. Details concerning proposed exploratory wells are:

Gulf Oil Company "Meadow Lake Inc. 1-ST" 6,000' depth
NE$\frac{1}{4}$, sec. 19, T. 38 S., R. 10 E.

Gulf Oil Company "Farell-Utley 1-ST" 6,000' depth
NE$\frac{1}{4}$, sec. 5, T. 39 S., R. 20 E.

The firm is expected to begin drilling in Oregon by mid-summer after completing its exploratory program in northern California.

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EASTERN OREGON GEOLOGIC MAP ISSUED

A preliminary uncolored edition of the long-awaited geologic map of eastern Oregon (companion to the western Oregon geologic map published in 1961) is now available as U.S. Geological Survey Miscellaneous Field Studies Map MF-495. The map, prepared in cooperation with the Oregon Department of Geology and Mineral Industries and compiled by George W. Walker, is for sale by the U.S. Geological Survey, Distribution Section, Federal Center, Denver, Colorado 80225. The price is $1.00.

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TEN-YEAR BIBLIOGRAPHY SUPPLEMENT PUBLISHED

The fifth supplement to the "Bibliography of the Geology and Mineral Resources of Oregon" has been published by the Department as Bulletin 78. This 200-page bulletin, which includes a comprehensive subject index, covers published and unpublished materials on the geology and mineral resources of the state released during the ten-year period January 1, 1961 to December 31, 1970. This includes master's theses and doctoral dissertations known to the Department from all universities, and because of their inclusion in this publication, no further supplements to Misc. Paper no. 7, "Bibliography of Theses on Oregon Geology," will be issued.

Bulletin 78 can be purchased from the Department's offices at Baker, Grants Pass, and Portland for $3. Still available are the first supplement, Bulletin 33, for $1.00, and the fourth, Bulletin 67, for $2.00.

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VAN GORDON BECOMES DEPARTMENT BOARD MEMBER

H. Lyle Van Gordon of Grants Pass has been appointed to the Department's Governing Board to succeed Donald McGregor, who died in February.

Van Gordon was born in Cove, Oregon, but spent his early years in Nevada. He attended the University of Nevada, gained experience in lead, silver, and gold mines, and during World War II was with the War Manpower Commission in magnesium research and process control. He moved with his family to Grants Pass in 1944 and in 1950 joined Pacific Power and Light Co., doing construction, marketing and customer relations work; he now is Customer Representative. He has been active in local civic groups and regional organizations and received the Grants Pass Distinguished Citizen Award for 1965. Of his recent appointment, he states, "This is the finest and will be the most interesting and rewarding opportunity to serve."

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NEVADA PLACER GOLD DEPOSITS SUMMARIZED

The U.S. Geological Survey has published "Placer Gold Deposits of Nevada," by Maureen G. Johnson, as Bulletin 1356. The publication describes 115 placer districts which produced gold between 1849 and 1968. History, production, and possible lode source are given together with location and access.

The 118-page bulletin is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Price - $2.00.

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AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final – no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed)

BULLETINS

8. Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller . . . $0.40
26. Soil: Its origin, destruction, preservation, 1944: Twenhofel 0.45
33. Bibliography (1st suppl.) geology and mineral resources of Oregon, 1947: Allen. . 1.00
35. Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin. . . . 3.00
36. Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2 1.25
39. Geology and mineralization of Morning mine region, 1948: Allen and Thayer . . 1.00
46. Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey 1.25
49. Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch . . . 1.00
52. Chromite in southwestern Oregon, 1961: Ramp 3.50
57. Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors . . . 3.50
58. Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass 5.00
60. Engineering geology of Tualatin Valley region, 1967: Schlicker and Deacon . . . 5.00
61. Gold and silver in Oregon, 1968: Brooks and Ramp 5.00
62. Andesite Conference Guidebook, 1968: Dole 3.50
64. Geology, mineral, and water resources of Oregon, 1969 . . . . . 1.50
66. Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre 3.75
67. Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts 2.00
68. The Seventeenth Biennial Report of the State Geologist, 1968-1970 . . . . . 1.00
69. Geology of the Southwestern Oregon Coast, 1971: Dott 3.75
70. Geologic formations of Western Oregon, 1971: Beaulieu 2.00
71. Geology of selected lava tubes in the Bend area, 1971: Greeley. 2.50
72. Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows . . . 3.00
73. Geologic formations of Eastern Oregon, 1972: Beaulieu 2.00
74. Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others 7.50
75. Geology, mineral resources of Douglas County, 1972: Ramp 3.00
76. Eighteenth Biennial Report of the Department, 1970-1972 . . . . . 1.00
77. Geologic field trips in northern Oregon and southern Washington, 1973 . . . . 5.00
78. Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts, et al. . . in press

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck 2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King 0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 37) . . 0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker 1.00
Geologic map of Lebanon quadrangle, Qregon, 1956: Allison and Felts 0.75
Geologic map of Bend quadrangle, and portion of High Cascade Mtns., 1957: Williams 1.00
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka 1.50
GMS-2: Geologic map, Mitchell Butte quad., Oregon: 1962, Corcoran and others . . 1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka . . . 1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others
[sold only in set] Flat $2.00; folded in envelope 2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess 1.50

OIL AND GAS INVESTIGATIONS SERIES

1. Petroleum geology, western Snake River basin, 1963: Newton and Corcoran . . . 2.50
2. Subsurface geology, lower Columbia and Willamette basins, 1969: Newton . . . 2.50

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19. Brick and tile industry in Oregon, 1949: Allen and Mason 0.20
21. Lightweight aggregate industry in Oregon, 1951: Mason 0.25
24. The Almeda mine, Josephine County, Oregon, 1967: Libbey 2.00

MISCELLANEOUS PAPERS

1. Description of some Oregon rocks and minerals, 1950: Dole 0.40
2. Key to Oregon mineral deposits map, 1951: Mason. 0.15
   Oregon mineral deposits map (22" x 34"), rev. 1958 (see M.P. 2 for key) 0.30
4. Rules and regulations for conservation of oil and natural gas (rev. 1962). 1.00
5. Oregon's gold placers (reprints), 1954 . . . . . 0.25
6. Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton 1.50
7. Bibliography of theses on Oregon geology, 1959: Schlicker 0.50
7. (Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts 0.50
11. A collection of articles on meteorites, 1968, (reprints, The ORE BIN) 1.00
12. Index to published geologic mapping in Oregon, 1968: Corcoran. 25
13. Index to The ORE BIN, 1950-1969, 1970: Lewis 0.30
14. Thermal springs and wells, 1970: Bowen and Peterson 1.00
15. Quicksilver deposits in Oregon, 1971: Brooks 1.00

MISCELLANEOUS PUBLICATIONS

Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 . . . . . 0.25
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Postcard - geology of Oregon, in color . . . . . 10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00

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