

## INVESTIGATIONS OF THE EARTHQUAKE OF NOVEMBER 5, 1962, NORTH OF PORTLAND

By  
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### Introduction

Earthquakes are one of the most destructive of the earth's natural phenomena. The larger earthquakes provide the bulk of our information about the interior of the earth, smaller quakes much of the information on nearby crustal and subcrustal structures. Seismograms (recordings) of the November 5, 1962, Portland earthquake and later shocks in the Northwest written at different seismic stations are being analyzed to provide information on these earthquakes and on the local crustal structures in the Northwest. These analyses concern locating earthquake epicenters and determination of their origin times, depths of foci, mechanisms of faulting at the source, and the nature and configuration of the crust and subcrustal material.

The Portland earthquake was the largest shock to occur in Oregon since the recent installations of the several new seismic stations in the Pacific Northwest. Although damage resulting from this shock was minor, as indicated in a preliminary report (Dehlinger and Berg, 1962), the shock is of considerable seismological importance. Because it was large enough to be recorded at the newly installed as well as at many of the older seismic stations, and because its epicentral location was known approximately from the felt area and from on-site recordings of aftershocks, this earthquake has provided the first significant data to be used for constructing travel-time curves for Oregon. The seismograms also provided data for a better understanding of the source mechanism associated with the Portland shock.

Sufficient energy was propagated from the focus to trip the U. S. Coast and Geodetic Survey strong-motion seismographs located in Portland, such

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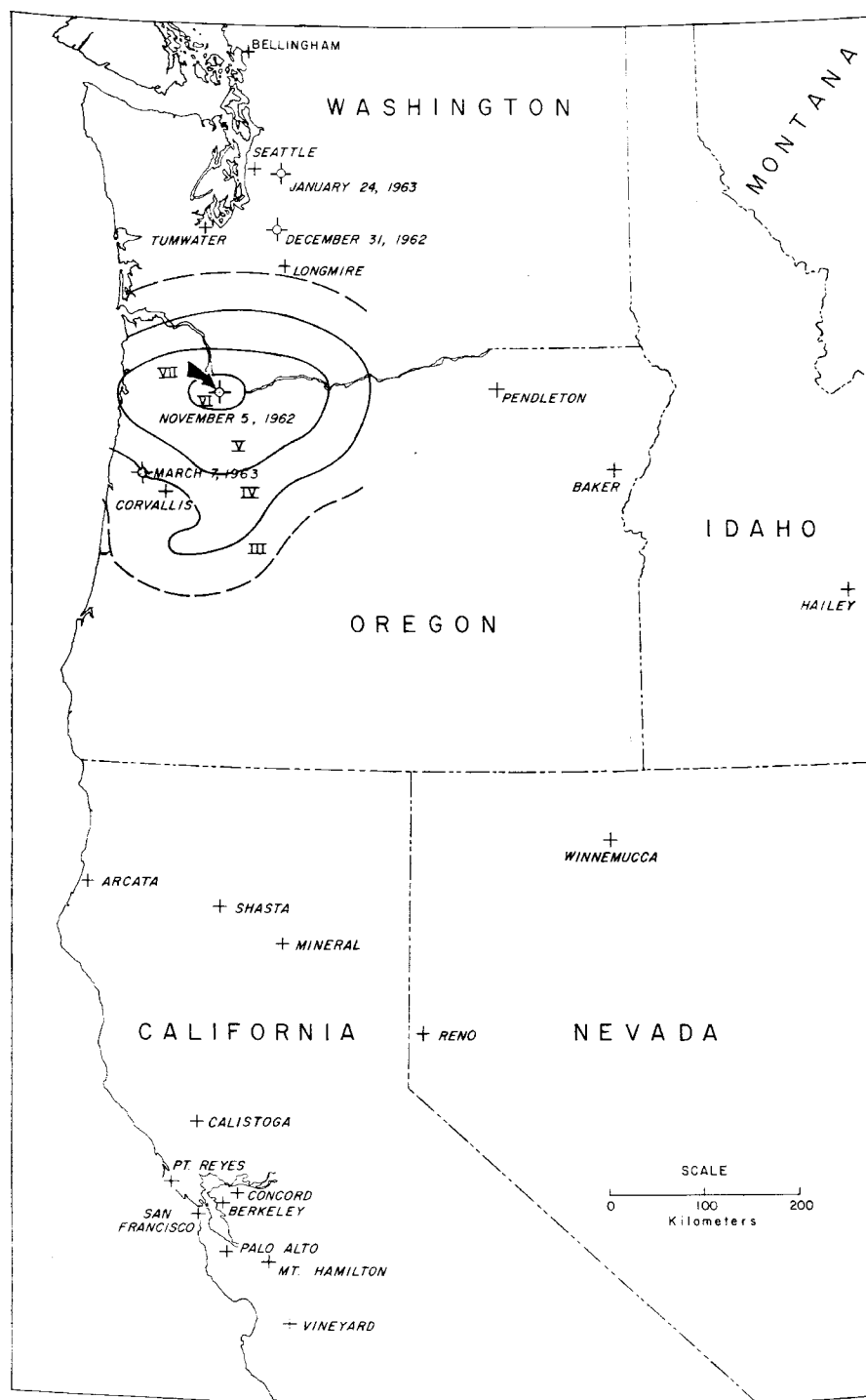


Figure 1. Location and isoseismal map, showing (1) epicenters of the November 5 (Portland), December 31, January 24, and March 7 shocks; (2) locations of seismic stations; (3) isoseismal lines of felt area for the Portland shock (isoseismal map reproduced from Dehlinger and Berg, 1962).

that measurements of ground acceleration were obtained. Conventional seismographs at most of the stations in Oregon, Washington, and Idaho went so far off scale with the first arriving waves that arrivals of very few of the later waves could be measured. At the more distant stations in California and Nevada, later arrivals were measured.

Aftershocks nearly always occur subsequent to an earthquake. Numerous aftershocks followed the Portland temblor, about 50 of which were recorded over a period of 18 days by three portable seismic stations in the Portland area.

## Seismology

### Recording stations

Seismograms were analyzed from more than 26 stations (Fig. 1) recording this shock. Eight of these stations are in Oregon, Washington, and Idaho. Because of their relative proximity to the source or their higher instrumental magnifications, these stations provided most of the data used in determining the epicentral location. The stations are located at:

Corvallis, Oregon (lat.  $44^{\circ}35.1'N$ , long.  $123^{\circ}18.2'W$ ).  
Baker, Oregon (lat.  $44^{\circ}50.9'N$ , long.  $117^{\circ}18.3'W$ ).  
Pendleton, Oregon (lat.  $45^{\circ}36.7'N$ , long.  $118^{\circ}53.0'W$ ).  
Seattle, Washington (lat.  $47^{\circ}39.3'N$ , long.  $122^{\circ}18.5'W$ ).  
Longmire, Washington (lat.  $46^{\circ}45.0'N$ , long.  $121^{\circ}48.6'W$ ).  
Tumwater, Washington (lat.  $47^{\circ}05'N$ , long.  $122^{\circ}56'W$ ).  
Bellingham, Washington (lat.  $48^{\circ}44.2'N$ , long.  $122^{\circ}29.0'W$ ).  
Hailey, Idaho (lat.  $43^{\circ}38.9'N$ , long.  $114^{\circ}16.0'W$ ).

Sixteen of the stations are in central and northern California and two in western Nevada. All but one of these 18 stations are part of the University of California network of seismic stations for detecting and locating earthquakes in California, one of the outstanding such networks in the world.

Five of the eight stations in Oregon, Washington, and Idaho have new instruments that were installed during the past year. The stations at Corvallis\* and at Longmire, the latter operated by the University of Washington,

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\* The Corvallis station was set up in 1950 by the University of California and operated by the Oregon State University Department of Physics as part of the University of California network of stations. In 1962 the instruments were replaced with the new standardized units. The station is no longer part of the University of California network; it is now operated by the Geophysics Research Group, Department of Oceanography, Oregon State University.

are part of the world-wide network of Standard Stations equipped with uniformly calibrated sets of short- and long-period seismographs, provided and installed by the U.S. Coast and Geodetic Survey as part of the VELA UNIFORM\* program. The Blue Mountain Seismological Observatory at Baker, Oregon, is one of the most sensitive seismic stations in existence. It contains 21 seismometers, 10 of which are part of special arrays which provide for recordings at exceptionally high signal-to-noise ratios. This observatory is one of five similar ones established in the United States as part of the VELA UNIFORM program. The Pendleton and Hailey stations are semipermanent stations, operated by the Geotechnical Corp. of Dallas, Texas, as part of the VELA UNIFORM program. These stations have very sensitive short- and long-period seismographs. Except for the Corvallis station, which operated with the old instruments, the only stations operating in western Oregon and Washington prior to 1961 were the University of Washington stations at Seattle and Tumwater.

In addition to the permanent and semipermanent stations, three portable stations were set up in the vicinity of Portland to record aftershocks. These were operated by the Stanford Research Institute for 18 days, beginning three days after the main shock. Each portable station consisted of an array of exploration-type seismometers.

#### Travel-time curves

Accurate travel-time curves are of great value in locating earthquake epicenters. Prior to the Portland shock, travel-time curves applicable to California had been used in Oregon, since there were too few seismic stations in and around Oregon to develop such curves. However, crustal thicknesses and crustal and subcrustal velocities are not likely to be the same in the two areas. The earthquake in Portland and three later quakes in western Washington and Oregon (December 31, 1962, lat. 47°02'N, long. 121°58'W; January 24, 1963, lat. 47°28'N, long. 121°57'W; March 7, 1963, lat. 44°46'N, long. 123°37'W) recorded at seismic stations in the Northwest provided materials for construction of preliminary travel-time curves for Oregon and vicinity.

Although these travel-time curves will not be complete until either many more local shocks are recorded at the present stations, or a larger number of stations are established to record future local shocks, they have

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\* A large-scale program sponsored by the U.S. Department of Defense for detecting and for developing methods of detecting the detonation of large underground nuclear explosions, and for developing methods of differentiating recordings of explosions from those of earthquakes.

been significant in investigating the shock north of Portland. The preliminary curves do indicate that either (1) the subcrustal compressional ( $P_n$ ) and shear ( $S_n$ ) wave velocities are somewhat lower in western Washington, Oregon, and northern California than are the comparable velocities in a southeasterly direction east of the Cascade Mountains, or (2) the crust of the earth (that is, material above the Mohorovicic discontinuity\*) thins in an easterly direction across eastern Oregon. The latter is not considered as likely. Recordings in Oregon and Washington of shocks originating in Idaho or Utah must be awaited, however, to establish whether present velocity determinations across eastern Oregon are correct. Recordings of numerous local shocks in western Oregon and Washington will also be required before travel-time curves can be established for different compressional (P) and shear (S) waves traveling within the crust.

#### Main earthquake

The epicenter and origin time of a shock indicate the location on the surface and the time of occurrence of the initial source motion. Directions of ground displacements at the receiving stations resulting from the incident compressional wave are determined by the initial source motion. The source is considered to be a fault in which the rupture progresses along the fault surface for the duration of the shock. This duration is usually short. From seismograms of the Portland shock, it was estimated that the source motion lasted no more than a few seconds.

Epicenter and origin time: With the new travel-time curves, the earthquake epicenter was placed at latitude  $45^{\circ}36'N$ ,  $122^{\circ}40'W$ , which is north of Portland and near Vancouver, Washington. The origin time was set at 7 hr 36 min 43.0 sec PM, PST, November 5 (3 hr 36 min 43.0 sec, GCT, November 6). These values provided smooth plots on the travel-time curve for the  $P_n$  waves at all stations in Oregon, Washington, and Idaho, except at Tumwater, which exhibited early arrival times. They also provided for satisfactory plots at most of the stations in California and Nevada.

Magnitude and intensity: The magnitude of the shock is placed at 5

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\* Seismic discontinuity about 35 km below the continents and about 10 km below the oceans which separates the earth's crust and mantle.

on the Richter scale\*. Magnitudes of 4 3/4 were obtained from seismograms recorded at Corvallis (only an approximation because amplitudes were offscale during much of the recording), and 5 1/4 to 5 1/2 from those at Palisades, New York, and 4 3/4 from those at Berkeley, California.

The maximum intensity was VII on the Modified Mercalli Scale, 1956 version (based on a maximum of XII; see Richter, 1958, p. 137 for complete scale). This was observed in north Portland, where a ceiling light fixture fell to the floor in a city library; in other parts of Portland masonry was cracked and some chimneys were toppled. This intensity is also consistent, according to Richter's findings (Richter, 1958, p. 140) in California, with accelerations recorded by the U.S. Coast and Geodetic Survey strong-motion seismographs in Portland. These instruments recorded a maximum ground acceleration of 0.16 g (vertical component of 0.076 g and two horizontal components of 0.103 g and 0.096 g). The decrease in intensity away from the epicenter is illustrated by the isoseismal lines in Figure 1; these lines are reproduced from Dehlinger and Berg, 1962.

Depth of focus: The focal depth could not be determined accurately because all seismic stations were too far away. A best depth estimate is 15 to 20 km\*\*. Depth calculations were based on epicentral distances and travel times to the Corvallis, Longmire, and Seattle seismic stations, using the standard equation

$$h = \sqrt{(TV_p)^2 - \Delta^2}$$

where T is the travel time,  $V_p$  the velocity of propagation from focus to station, and  $\Delta$  the epicentral distance. Values of  $V_p$  were estimated since they have not yet been established for the Oregon-Washington area. The h is quite sensitive to small variations in velocity. A  $V_p$  of 6.1 km/sec to Corvallis gives a depth of 16 km; a  $V_p$  of 6.2 km/sec gives a depth of 28 km. An average velocity of 6.0 to 6.1 km/sec is consistent with the Corvallis arrival on the travel-time curves. Similarly, using a  $V_p$  of 6.4 km/sec to Longmire and 6.5 km/sec to Seattle, both sets of values being consistent with travel times and epicentral distances at these two stations, a focal depth of 15-20 km is obtained. Depth estimates could not be made from the arrival at Tumwater without resorting to excessive velocities; either

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\* Magnitudes according to this scale are based on ground amplitudes recorded at seismic stations. The scale ranges from 0, the smallest recorded shocks, to 8 3/4, the world's largest and most destructive earthquakes. For descriptions of the magnitude scale, see Richter, 1958, p. 340.

\*\* 1 Kilometer equals approximately 0.621 mile.

the arrival time at Tumwater was in error or waves arrived early because of anomalous conditions in the vicinity of the station.

Very small increases in the assumed average velocities result in a substantial increase in calculated depth; conversely for small decreases in the velocities. Clearly, the depth estimates also depend on the accuracy of the epicentral and origin-time determinations.

The best depth determinations are obtained at stations near the source. The Stanford Research Institute portable stations in the Portland area were well situated for aftershock depth determinations, but these calculations will not be completed for some time. The focal depths of aftershocks need not, however, be the same as that of the main shock, although experience in California has demonstrated that the average depth of aftershocks is usually about that of the main shock.

Source motion: The direction of displacement at the source was investigated from initial ground displacements recorded at the stations. For the eight stations in the Northwest, these initial displacements were:

Corvallis - north, with small down and east motions.

Baker - up, south, and west.

Pendleton - up (other two directions not determined).

Seattle - down, with small south and east motions.

Longmire - down, with small south and west motions.

Tumwater - down and south, with small east motions.

Bellingham - down, south, and east.

Hailey - up (other two directions not determined).

The displacements are plotted in Figure 2 at the respective station locations. This figure also indicates the quadrants with respect to an assumed northwesterly trending strike-slip fault in which initial ground motions of the direct and refracted compressional waves should be compressions or dilatations (Gutenberg, 1941, Figs. 1 and 2). As the observed initial ground motions were dilatations at Corvallis, Longmire, Tumwater, and were compressions at Pendleton, Baker, and Hailey, the source motion could have been along a northwesterly trending strike-slip fault with a right-handed displacement (as illustrated in Fig. 2), which is of the same sense as the San Andreas fault. The first-motion observations fit equally well a northeasterly trending strike-slip fault with a left-handed movement, of the same sense as the Garlock fault of California. The data are not consistent with a predominantly vertical fault motion; hence, the faulting would not be normal or reverse. However, some vertical component of motion may have

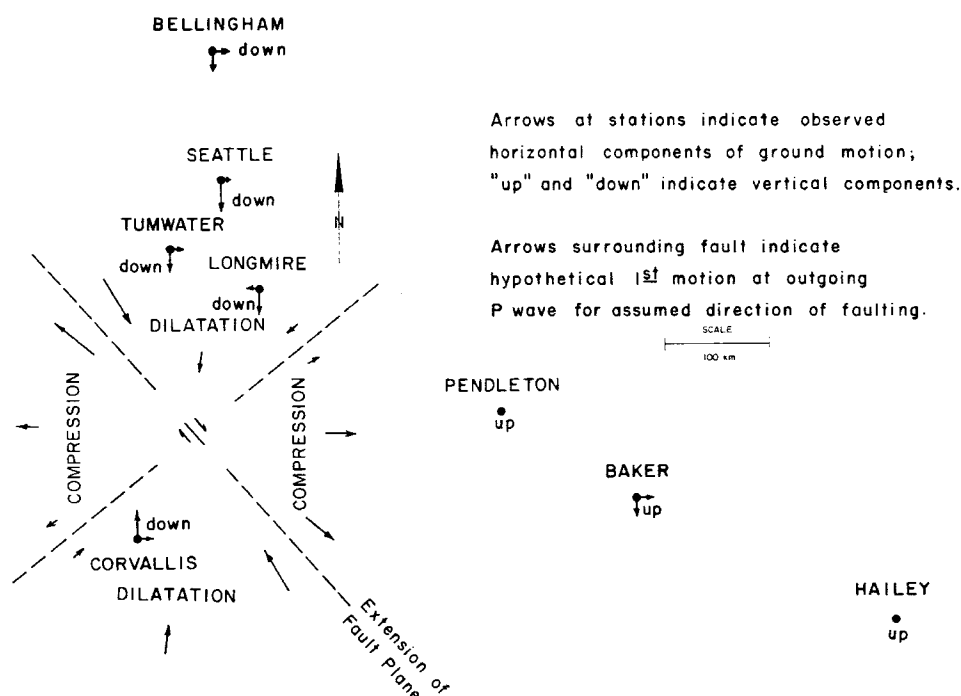


Figure 2. Components of first motions in the initial compressional wave recorded at the different stations; hypothetical dilatational and compressional first motions radiated from a northwesterly trending right-handed strike-slip fault.

accompanied the strike-slip motion.

If strike-slip faulting was the source motion, it then appears that the stress distribution acting in the Portland area has a maximum principal stress in approximately a north-south direction, with a minimum principal stress in the vertical direction.

### Aftershocks

Numerous aftershocks were recorded subsequent to the main shock. Apparently none of these were large enough to have been felt in the Portland area. Several of these were sufficiently large to have been recorded at Corvallis and at Longmire. Corvallis reported aftershocks until November 15. Several later shocks were recorded from the Portland area which were larger than the earlier aftershocks, occurring on December 18, 1962; February 26, 1963; and March 2, 1963. These later three are probably separate shocks, however.

Aftershock measurements were made with three portable seismic stations operated by the Stanford Research Institute in the Portland area between



November 9 and 26. The three stations recorded a total of 50 aftershocks during this time, one on the 9th, one on the 26th, and the others between the 10th and 23rd (Westphal, 1962).

The three stations were located at distances of 18 to 35 km from the epicenter (stations A, B, and C, Fig. 3); the high seismic noise level in the city necessitated station sites out of town. Sites of the initial stations were based on preliminary epicentral locations; they were found to be too far south. Hence, two of the stations were moved; Station A<sub>1</sub> was moved to A<sub>2</sub> (Fig. 3) and Station C<sub>1</sub> to C<sub>2</sub>. Station B was not moved. Each station consisted of six 4 1/2 cps seismometers arranged in L-shaped arrays to permit azimuthal determinations of incoming waves.

At a later time the Stanford Research Institute plans to make directionality and depth-of-focus computations of recordings at each portable station. These results will be made available when calculations are completed. The largest number of aftershocks, especially during the latter part of the recording time, were recorded at Station C<sub>2</sub> (Westphal, 1962), which is the station nearest to the epicenter of the main quake. The proposed epicentral location of the main shock is thus consistent with the present aftershock results.

## Geology

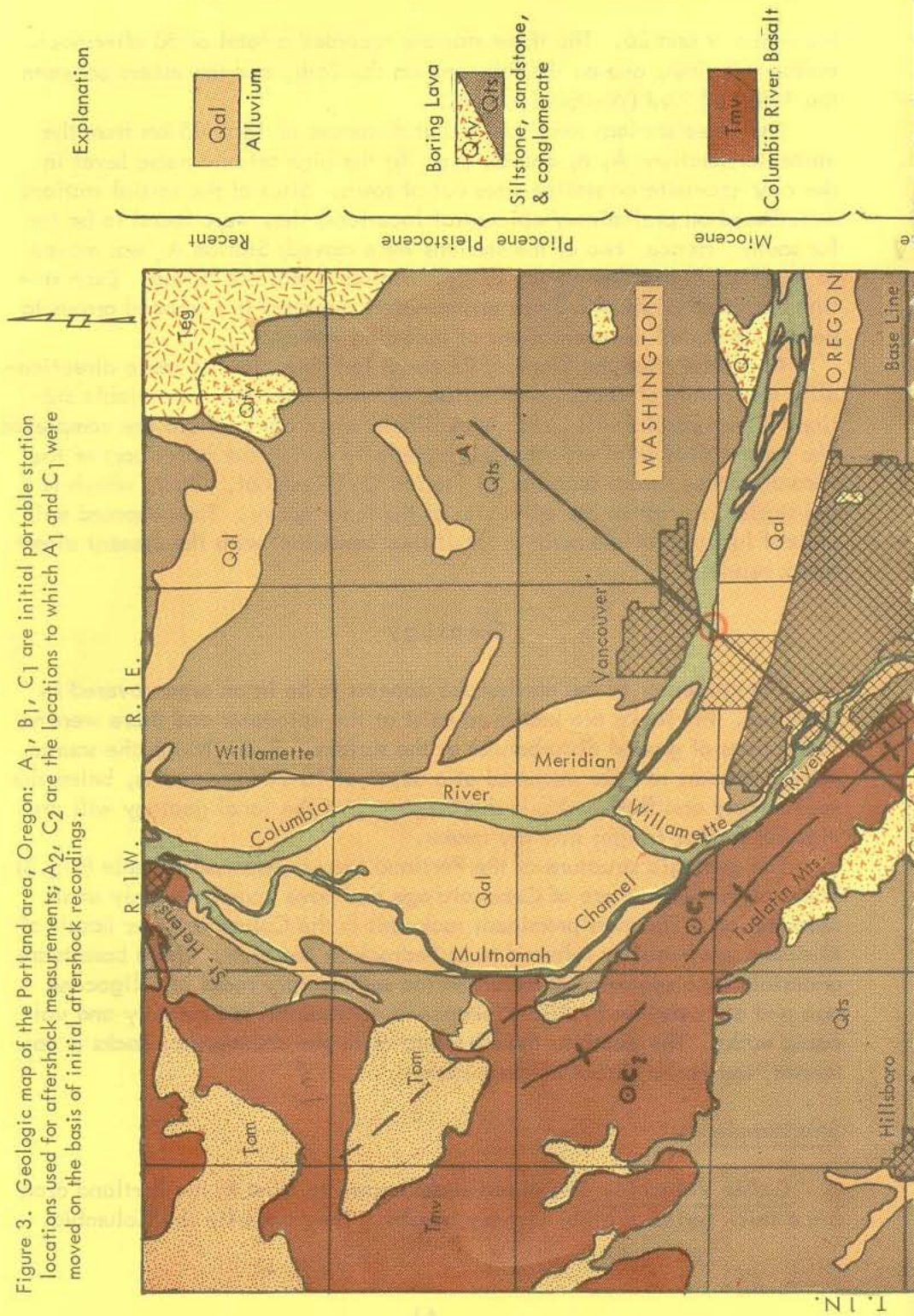
The epicenter of the earthquake appears to be in an area covered by alluvium. No faults are known to exist at the epicenter and there were no indications of ground disturbances at the surface. Even though the source motion appears to have occurred at a depth of 15-20 km, that is, below the sedimentary and flow rocks, a short summary of the local geology will provide for further insight into the quake.

The geologic structure of the Portland area is relatively simple (Fig. 3). Rocks at the surface are of Cenozoic age and have undergone only small deformation. The most prominent rock unit is the Columbia River Basalt of Miocene age, usually referred to as bedrock in the area. These basalts are underlain by a sequence of older marine sedimentary rocks of Oligocene age and are overlain by Plio-Pleistocene continental sedimentary and volcanic rocks. The depth to the basement or to pre-sedimentary rocks is not known, nor is the nature of these rocks.

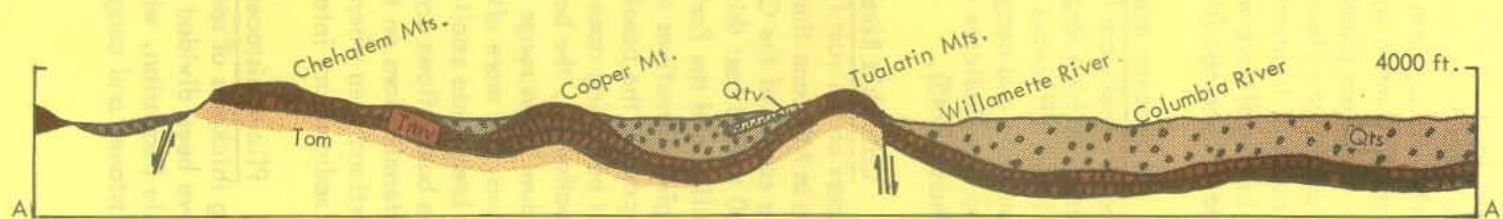
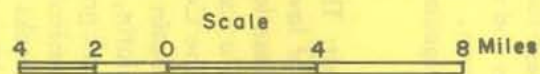
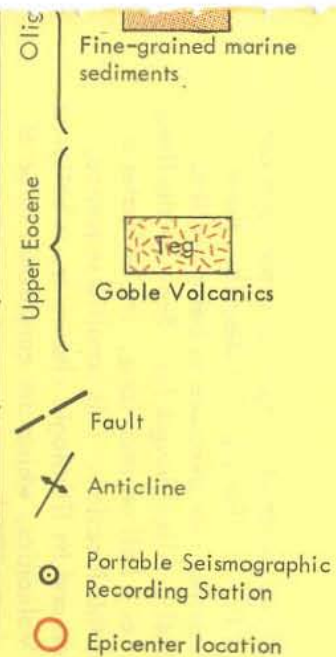
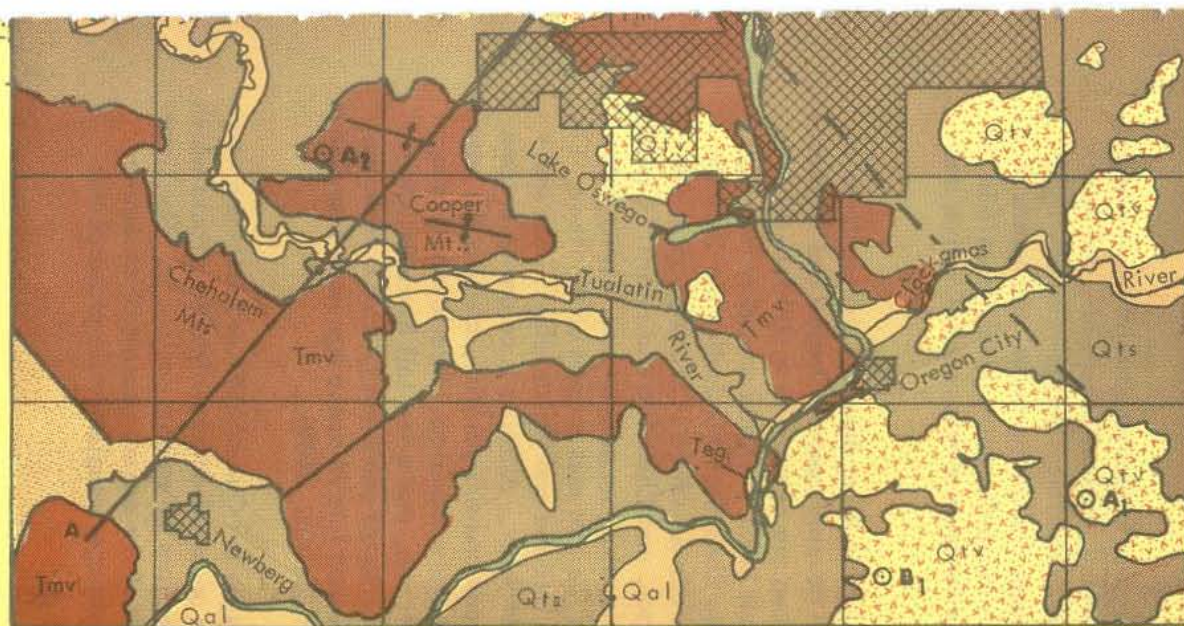
### Stratigraphy

Goble Volcanics: The oldest rocks known to exist in the Portland area are a thick series of early Tertiary basalts. They underlie the Columbia

Figure 3. Geologic map of the Portland area, Oregon: A<sub>1</sub>, B<sub>1</sub>, C<sub>1</sub> are initial portable station locations used for aftershock measurements; A<sub>2</sub>, C<sub>2</sub> are the locations to which A<sub>1</sub> and C<sub>1</sub> were moved on the basis of initial aftershock recordings.







River Basalt along the Willamette River south of Oregon City and crop out again northeast of Vancouver. Schlicker (1954, p. 27) describes these early Tertiary basalts in the Willamette River exposure as being mottled black and white with numerous zeolite-filled amygdules. Some of the flows have feldspar phenocrysts as much as a half an inch long. He estimates a thickness of at least 1,500 feet at this location. This basaltic sequence, because of its stratigraphic position and its lithologic character, is believed to be correlative with the Goble Volcanics, which are considered to be of late Eocene age (Wilkinson and others, 1946).

Oligocene marine sedimentary rocks: Extensive areas of marine sedimentary rocks are found north of Portland, around Scappoose, and to the west near Newberg. These rocks are predominantly fine-grained, light-colored tuffaceous shales and mudstones containing occasional lenses of limestone and conglomerate. Fossils found at various localities within the map area indicate an Oligocene age for most of these rocks (Warren and others, 1945).

Columbia River Basalt: The Columbia River Basalt in the map area is a part of the vast floods of lava that covered central Oregon and Washington in Miocene time. These lava flows are as much as 6,000 feet thick in the center of the Columbia Basin, but in the Portland area they are only 600 to 800 feet thick. The Columbia River Basalt underlies the Tualatin Valley and the Portland Basin and crops out where it is bowed up at the higher elevations on Tualatin, Cooper, and Chehalem Mountains. On fresh exposures the basalt is dark gray to black, fine grained and usually dense but becoming open and vesicular on the tops and bottoms of the flows. On weathering, the basalt breaks down into red and yellow clays. The individual flows range from 10 to 30 feet thick. Jointing is columnar in some flows, but more often is closely spaced and sub-parallel, causing the basalt to break into small rhombic blocks upon weathering. Interlayered among the basalt flows are thin beds of tuff, ash, and a few soil horizons. Age determinations on the Columbia River Basalt come mostly from outside the Portland area where fossils of middle and late Miocene age have been found in sedimentary interbeds (Lowry and Baldwin, 1952).

Plio-Pleistocene rocks: Overlying the Columbia River Basalt is a varying thickness of semiconsolidated to unconsolidated sedimentary rocks which have been divided into several formations by various geologists. The Troutdale Formation, which is at the base of the series, consists of sandstone, siltstone, and conglomerates. The younger conglomeratic phase of this

formation is frequently quite distinctive, since it contains light-colored, well-rounded quartzite pebbles unlike any bedrock in the area. The lower part, encountered largely in wells, is bedded sandstone and siltstone.

The Boring Lava stratigraphically overlies the Troutdale Formation. East of the Willamette River it forms several small volcanic cones and necks including Mount Tabor, Kelley Butte, and Mount Scott. On the west side of Tualatin Mountain, the Boring Lava occurs mainly as thin intracanyon flows. These flows differ mineralogically from the Columbia River Basalt in that they contain a great amount of olivine and have an expanded open texture. The Boring Lava is similar in appearance and age to the Cascade Andesite, the rock that makes up the bulk of the High Cascade flows. The Boring Lava is late Pliocene to early Pleistocene in age (Treasler, 1942).

Mantling Tualatin Mountain and many of the higher areas is a cover of silt ranging from light to dark brown in color. Lowry and Baldwin (1952) named this unit the Portland Hills Silt and pointed out features that made them believe it was deposited by the ancestral Columbia River during Pliocene time when relief was much less than at present. Other workers, including Trimble (1957) believed the silt to be of loessal origin; that is, to have been deposited by the wind in late Pleistocene time.

Unconsolidated gravels, sands, and silts underlie a major part of the area, including most of east and north Portland. These deposits, as much as 500 feet thick (Baldwin, 1959), were deposited during a time when either the Columbia River's flow was dammed northwest of the Portland area or sea level was higher than now. The effect was to create a large lake or sound into which alluvium washing through the Columbia River Gorge was deposited into quieter waters fanning out to fill the basin, leaving the coarser deposits at the mouth near Camas and Troutdale and grading finer to the west. The surface was veneered with coarser gravels and boulders by the Missoula Flood (Baldwin, 1957).

Recent alluvium: The present flood plain areas of the Columbia, Willamette, and smaller rivers are covered with deposits of Recent alluvium. These deposits, in most cases less than 50 feet thick, consist predominantly of fine-grained sediments derived from the upstream drainage areas.

### Structure

Tualatin Mountain, running diagonally through the area, is the most prominent structural feature on the map. This is an anticline that has been faulted on its northeast flank.

In the Tualatin Valley the rocks are folded down to form an elongate

synclinal basin. There the surface of the Columbia River Basalt, which is nearly 1,000 feet above sea level on Tualatin Mountain, drops to about 1,200 feet below sea level beneath Hillsboro and then rises again at Chehalem Mountain. Cooper Mountain is a small anticlinal fold on the southwest side of the Tualatin Valley. Chehalem Mountain forms the west edge of the basin; here the rocks have been uplifted, then faulted on the west side, leaving several hundred feet of Columbia River Basalt and underlying marine sedimentary rocks exposed in the escarpment.

On the east side of Tualatin Mountain, the surface of the Columbia River Basalt forms another alluvial-filled basin that reaches depths of at least 1,500 feet below sea level. To the east the basalt comes to the surface in the Columbia River Gorge about 20 miles away, while to the north and northeast it pinches out or is faulted out against older Eocene volcanics and sedimentary rocks that crop out around the margins of the basin.

Early geologists (Diller, 1915) believed the east-facing front of Tualatin Mountain to be the result of faulting. The theory was based on the unusually straight alignment of the east base of the hills, the general absence of surface exposures of the Columbia River Basalt, and the presence of the falls at Oregon City. Later, Treasher (1942) pointed out the lack of direct evidence for faulting and that the variations in the elevation of the basalt, as determined from water wells, could be accounted for by folding rather than faulting. Most of the recent publications dealing with the geology of the Portland area have ascribed to this later view. The presence of the Columbia River Basalt under younger sediments in west Portland at depths ranging from 125 to 500 feet precludes a fault of large vertical displacement along the front of Tualatin Mountain. The evidence that some displacement has taken place in the past, however, is very strong. The interpretation that fits the existing geologic conditions best is a normal fault with a vertical displacement of less than the thickness of the Columbia River Basalt, which is about 700 feet in this area. This would explain the horizontal flows just above the foot of the escarpment and account for the relatively low dips of the lava under the west side business district of Portland.

Other faults have been mapped along the surface to the west and southeast of Portland, some striking northwest and some northeast. It is believed that the earthquake occurred along one of these other faults, which would be buried beneath alluvium, or along a deeper fault that may not even extend into the sedimentary layer. The seismic evidence indicates that the movement was along a strike-slip fault, with a right-handed displacement if trending northwesterly, as illustrated in Figure 2, and a left-handed displacement if trending northeasterly. The fault was not believed to be

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either a north-south or east-west trending strike-slip type nor a reverse or normal type.

#### Recommendations

The new seismic stations and instruments in the Northwest have resulted in substantially more reliable determinations of local epicenters and are providing valuable data for determination of regional crustal structures. Much will be learned from data yet to be recorded by these stations. However, many more stations, with a variation in types of instruments, are needed. Two of the stations currently operating in Oregon and Idaho are mobile stations, operated to fill the needs of Project VELA UNIFORM; these cannot be considered as part of the permanent set of stations in the Northwest.

It is recommended that vertical seismometers be installed near Portland, the Oregon coast, and central and southeastern Oregon. Oregon State University is planning to install a station at Klamath Falls. Some stations, as at Portland, should have both high and low magnification units. At least one station should have Wood-Anderson torsion seismometers to provide for rapid and reliable magnitude determinations. A larger number of stations throughout Oregon would provide for better epicentral location of shocks; magnitude determinations; focal depth determinations; aftershock recordings; and data pertinent to the crustal and subcrustal structures and variations of these features in Oregon. Oregon is particularly well situated for such investigations.

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## NEW PROCESS TESTED ON OREGON LATERITES

The standard method for extracting alumina from aluminous-bearing rocks is the Bayer process. This process uses caustic soda solution to dissolve the alumina ( $\text{Al}_2\text{O}_3$ ) in the ore, leaving a residue high in iron, titanium, and silica to be discarded as waste. The dissolved alumina is then precipitated, calcined, and shipped to electrolytic reduction plants like those here in the Northwest for final production of aluminum metal. The principal disadvantage of the Bayer process is that it works well only on ores which contain less than 10 percent of silica. These high-alumina, low-silica deposits are called aluminous laterites or bauxites. Research chemists have, therefore, spent many years trying to develop a process capable of treating the more extensive higher-silica deposits that occur in many parts of the world. Several such processes have been invented, but so far none have been shown to be economically competitive with the Bayer process.

A recent method using sulphuric acid as the dissolving reagent has been developed in Melbourne, Australia, by Dr. T. R. Scott of the Commonwealth Scientific and Industrial Research Organization. The principal advantage of the Scott method is that it can handle ores much higher in silica content than is feasible for the Bayer process. Because there are large deposits of relatively high-silica laterite in Oregon, a composite sample containing approximately 15 percent silica and 35 percent alumina was sent to Dr. Scott, who kindly consented to test the sample to determine its ease of treatment by the sulphuric acid method. At the same time, another sample from Cowlitz County, southern Washington, was sent to Dr. Scott as an additional check.

Dr. Scott recently visited the department, while returning from a trip to South America, to explain his process in greater detail and to report on the results of his tests on the Oregon-Washington samples. Both were found to be amenable to treatment on a laboratory scale by the sulphuric acid process with very high-grade alumina being produced. The only difficulty experienced was that it was found necessary to calcine the Oregon sample to approximately  $700^{\circ}\text{C}$ . prior to digestion in acid in order to lower contamination of the alumina by iron.

The question, whether the sulphuric acid method can treat Northwest laterites at a price competitive with higher quality ores using the Bayer process, cannot be answered until large-scale pilot plant tests are made on these deposits.

Unfortunately, there is no such pilot plant in operation at the present time. The U.S. Bureau of Mines at Albany has been studying various processes for producing alumina from Northwest laterites for several years.

Their work so far has also been on only a laboratory scale, but their future plans are to build a pilot plant if one of these processes shows economic promise and sufficient funds become available. Perhaps within the next few years the demand for domestic sources of medium-grade aluminum ore will result in a new mining operation for Oregon. The state will then have a completely integrated aluminum industry from the raw material to the finished product.

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#### WILDERNESS BILL PASSED BY SENATE

Once again the Senate has overwhelmingly passed and sent to the House a bill (S.4) to establish a National Wilderness Preservation System in which mining and other commercial activity would be virtually banned. The vote was 73 to 12, not much changed from the 78-to-8 vote by which the Senate passed a similar measure in 1961.

The wilderness system would be composed initially of about 13.5 million acres of national forest areas now designated as wilderness, wild or primitive, and a roadless canoe area in northern Minnesota. At the present, the mining laws apply in general to all of these except the canoe area.

As in 1961, Senator Frank Church (Idaho) led the floor fight for enactment. The minority was spearheaded by Senator Peter H. Dominick (Colo.), who substituted for Senator Gordon Allott (Colo.), absent for much of the debate because of a death in his family. (American Mining Congress News Bulletin, April 12, 1963.)

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#### GRUENING BILL DESIGNED TO AID MINING INDUSTRY

Senator Ernest Gruening (Alaska) has introduced legislation designed to "aid our ailing mining industry." Speaking on the Senate floor, Gruening said, "It would help the operator who is confronted with a fixed price for his product and a continually increasing cost of production. The miner today has to find higher grade ore. He must also find a means to reduce his cost. The Federal government can help lick its growing dependence upon foreign sources for its metals and minerals by sharing the risk and cost, thereby stimulating exploration and, hopefully, increasing production."

The bill (S. 1279) would amend Public Law 85-701, which established the Office of Minerals Exploration. (American Mining Congress News Bulletin, April 12, 1963)

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## HAZARD HUNTING IN THE HILLS

By breaking a few simple rules practically anybody taking a vacation in the mountains can have a really dangerous, if not fatal, experience at very little effort or expense. The list of hazards which can be encountered ranges from simple drowning or asphyxiation to being crushed by falling rock. Abandoned mines offer excellent opportunities, and hardly a year elapses without reports of accidents in them. Old mine timbers may look sound and sturdy, but don't kick them as a test. All too often they collapse and bring down tons of rock. Large mines often have pockets of air deficient in oxygen. Unless a light with an open flame is carried, this deadly condition cannot be detected and asphyxiation may result. Underground winzes and shafts sunk below the tunnel level often have rotten timbers hiding their presence. Persons crashing through these openings feel lucky if they merely fall into water, since the bottom of the hole may be a hundred feet or more below. Many mines have interesting mineral specimens sticking to the walls and roof and incautious picking and prying may bring down not only the specimen but part of the roof as well. To make disaster doubly sure, always test doubtful timbers and pick at the roof while standing on the side away from the entrance. This insures secure entombment. To further perfect the hazard don't tell anybody where you are going, go alone, and don't leave a note at the mine entrance. With luck you won't be found for months.

One of the big thrills for the hazard seeker comes with the sudden and unexpected discovery of an open shaft on a hillside covered with underbrush. The first step down is a big one, several hundred feet perhaps, but after that there will be little if any walking to do. Animal lovers have a special thrill in store for them in some old tunnels. These abandoned man-made openings often become the home of porcupines, snakes, bobcats, skunks, and even cougars. An orderly retreat is suggested -- if the animal is discovered on your way into the mine. Meeting one of these animals on the way out presents an entirely new and interesting situation.

In summary, here are the ways to have a hazardous vacation in the hills: (1) enter all the old mine workings you can but don't tell anybody about it; (2) use a flashlight, which doesn't need oxygen; (3) pick and pry at rocks and timbers overhead; (4) tramp nonchalantly over planks on the tunnel floor without testing them; (5) climb up and down all the ladders in the shafts but don't bother to keep track of the number you have climbed -- you may get lost; (6) don't worry about old mine shafts half hidden in underbrush, they can take care of themselves; (7) ignore the fact that to many animals an old mine tunnel is home and that they intend to defend it; and

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(8) forget that nitroglycerine is practically indestructible, that is, until you bumped that old dynamite box you found way back in the mine.

One last little thought. Leave your keys in the car, so the next of kin can drive it away. Those towing charges will only decrease your estate listed in the will you forgot to have drawn up.

R.S.M.

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## GOVERNOR HATFIELD BACKS MINING

Mark O. Hatfield, Governor of Oregon, called a meeting of Oregon's hard-rock mining people April 11 to obtain views on how Oregon's mining industry could be bolstered. In his opening remarks to the 35 prospectors, mine owners, and government officials gathered in his offices in the Capitol, Governor Hatfield stressed the need for broadening Oregon's economic base and stated that mining had not received the attention in Oregon which he thought it deserved. He cited the economic pressures the Iron Curtain countries were exerting on certain strategic minerals and oil and called for an increase in mineral exploration so that America can remain strong. Noting that metal mining had been on a downward trend in Oregon and in the West for many years, Governor Hatfield asked the group for suggestions on how best he and the State Executive departments concerned with mining could help reverse the trend. The conclusions coming from the meeting were:

(1) Utilization of Federal lands for prospecting and mining should be according to Federal law and not restrictive administrative regulation.

(2) Federal legislation should be proposed to shorten the period of time now taken by the Administrative Procedures Act on determinations concerning mining claims, be they for patent proceedings or for determinations under Public Law 167 (examinations of claims to determine if the claim holder or the Federal Government has management of surface rights).

(3) Commendation was given to the U.S. Forest Service for its new policy of assigning mining engineers to those forests having a high incidence of mining claims within the forests, and a recommendation was made that the U.S. Forest Service go one step farther by establishing a staff mining engineer at the Washington level to determine policies for the local engineers.

(4) The state should embark upon research programs through the Department of Geology and Mineral Industries in the field of geophysics, and assistance should be given by the Department of Planning and Development through market research.

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