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A Study of the October 12, 1877
Oregon Earthquakes

by

Paul C. Thenhaus

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This report is preliminary and has not been
edited or reviewed for conformity with U.S.
Geological Survey standards and nomenclature.

ABSTRACT

Historic accounts indicate two earthquakes occurred in northern Oregon on October 12, 1877. The first event, of Modified Mercalli Intensity III, took place at Cascades, Oregon (now Cascade Locks) at approximately 9:00 a.m. The second earthquake, of Modified Mercalli intensity VII, occurred in Portland, Oregon, at approximately 1:53 p.m.

INTRODUCTION

A prerequisite to any study of earthquake hazard assessment is that the earthquakes of concern are located as accurately as possible in accordance with available data. This is of considerable importance with the larger earthquakes (M.M. \geq VII). Since these earthquakes are relatively few in number, the location of each epicenter is critical to the delineation of seismogenic zones, and to the production of probabilistic seismic risk maps.

Historic and recent earthquake catalogues cite two earthquakes as having occurred in Oregon on October 12, 1877; there is little agreement among them, however, on the times, locations, and intensities of these earthquakes. Sufficient data exists in the original accounts of the events surrounding these earthquakes to remedy these discrepancies.

HISTORY OF THE EARTHQUAKES IN THE LITERATURE

The first compilation of earthquake occurrences in which the October 12, 1877 events were cited was in "The American Journal of Science and Arts," nos. 85-90, 1878. C. G. Rockwood summarized the then recent earthquakes of the western hemisphere. His account of the 1877 Oregon events is as follows:

Oct. 12. Quite severe shocks were felt in Oregon, occurring in Portland at 1:53 p.m., two shocks being noticed; at Marshfield, Clackamas Co., at 1:45 p.m.; and at Cascades at 1:52 p.m. (Another shock was felt at Cascades at 9:00 a.m.) The vibrations in each case from north to south and were sufficiently violent to overthrow chimneys.

Edward S. Holden provided a more condensed citation of the earthquakes in his catalogue of "Earthquakes on the Pacific Coast" (1898). He was also the first to assign an intensity to the earthquake using the Rossi-Forel scale.

1877. October 12; 1:53 p.m.; VIII Portland, Oregon; 1:45 p.m. Marshfield, Oregon; 1:52 p.m. Cascades, Oregon; 9:00 a.m. Cascades, Oregon. C.G.R. (Chimneys overthrown).

Harry F. Reid, in an unpublished earthquake catalogue, inferred that the 9:00 a.m. Cascades shock occurred on October 13, 1877. He also assigned the Portland quake an intensity VII.

Townley and Allen in their catalogue of 1939 separated the citations of the 9:00 a.m. shock at Cascades from the 1:53 p.m. shock at Portland. They dated both quakes as occurring on October 12, 1877. Drawing from Rockwood's account they concluded that in both cases chimneys had been overthrown; however, a Rossi-Forel intensity of VIII was assigned only to the Portland quake. They noted that in Plummer's report (1896) it was not stated that chimneys were overthrown.

Berg and Baker (1963) took the opposite position of Townley and Allen and assigned a M.M. intensity of VIII to the 9:00 a.m. shock at Cascades and an M.M. intensity of III to the 1:52 p.m. Portland quake.

The National Oceanic and Atmospheric Administration in "Earthquake History of the U.S." (1973) assigns a M.M. intensity of VII to an earthquake that occurred on October 12, 1877, with the location given as the "Cascade Mountains." No mention is made of a second earthquake.

The Rinehart catalogue, partially listed in W. Hays, and others (1975), lists only one earthquake as occurring on October 12, 1877, in Oregon and assigns it a M.M. intensity of VIII. The location is given as longitude 122.5°, latitude 44.0°. This places the earthquake in west-central Oregon, far beyond the areas of reported damage, in fact, even beyond the felt area. The time of the event is noted as being 5:00 p.m.

It is not the intent of this paper to analyze and qualify the numerous inconsistencies of the historical record. The fact that they exist unqualified in numerous catalogues will suffice to render any one of them questionable. Clarification of the true nature of these earthquakes can only come from the original accounts as they were published in the October 13, Saturday morning edition of The Daily Oregonian, 1877.

DATA: The Original Accounts

The following article is reprinted in its entirety from The Daily Oregonian newspaper as noted above.

AN EARTHQUAKE PASSES OVER THE NORTHWEST AND "CALLS IN" ON
PORTLAND--INCIDENTS OF THE SHOCK

Diseased nature oftentimes breaks forth
In strange eruptions, and the teeming Earth
Is with a kind of colic pinched and vexed
By the imprisoning of unruly wind
Within her womb, which for enlargement striving
Shakes the old beldame earth and topples down
Steeple and moss grown towers.--*Shakespeare.*

We are accustomed to contrast the instability of things in general with the stability of our planet, and "as solid as the earth" is acknowledged everywhere as the standard of immobility. But like many of man's fondest fancies, the delusion quickly vanishes when we feel the earth beneath us tremble. From shipwreck, we can "man the boats," can fly from flood or the dangers of conflagration; but amid the convulsions of an earthquake, danger is equally great on every side, and flight is simply folly. We seem brought face to face with the mighty power of God, and upon the very verge of the undiscovered world.

Yesterday afternoon at seven minutes before two o'clock, a distinct earth shock, followed in a few seconds by another and severer one, passed over the city from north to south. It was not, as is usually the case, preceded by premonitory rumblings, but came with terrifying suddenness. The scene on the principal streets, as the people became conscious of the cause of the agitation, was one of wildest confusion and, for a moment, of terror. From houses and stores, people with white, scared faces, rushed into the streets, cigars dropped from the mouths of smokers, horses snorted and dogs whined with fear, the air, as well as the earth, seemed filled with a mysterious and awful power--the streets seemed turned into a mad carnival of fear. This was for one moment; the next, everybody was trying to convince everybody else that he "wasn't a bit scared."

While the shock was very severe, or, at least, seemed so to Oregonians, it was not accompanied by loss of life or destruction of property to any great extent.

A panic was created at each of the public schools, and children made for the open air without considering the manner of their going. At the North building they rushed pell-mell down stairs, and in the turmoil several small children were severely bruised. At the Central and High schools a similar occurrence took place, and in Harrison street school the terror of the children was awful. Several windows were broken, and it seemed as though the house would certainly fall.

The shock was much harder in the southern part of the city, and many residences were well shaken up. Several windows in the house of J. L. Atkinson were broken, and two chimneys were knocked off Dr. Glenn's house on Second and Columbia streets.

In the county jail, several feet below the surface, it was very severe, and a stove was knocked from its "moorings" and thrown over.

The shock seems to have had particular spite against the Oregon Furniture Company's building on First and Yambill streets, and cracked a large and valuable plate glass window in front of the salesroom. This is the only real loss yet reported.

There were many incidents that would be of interest, but space forbids further mention.

A private telegram gives information that the shock was felt on the Sound, and the officers of the Astoria boat report that it was very distinct at points down the Columbia.

The following dispatch explains itself:

Cascades, Oct. 12

Two distinct shocks of earthquake were felt today. One at 9 A.M. and one at 1:52, from north to south.--the last very heavy.

Dalles and above report nothing felt there.

A gentleman who came from Salem last evening says that nothing was felt there or further up the valley.

Three shocks were felt at Hubbard. They made the household crockery rattle.

Marshfield, Clackamas Co., Oct. 12

Earthshake felt at this place today at 1:45 precisely, Stone's time. Vibrations were from north to south and very distinct, so much so as to rattle windows and all loose or moveable articles about the house. It was felt by all persons who were indoors, and lasted about four seconds-- the second and most severe shake experienced by the writer during a residence of thirty years in the state.

T. J. Matlock

ANALYSIS

Intensities

Table 1 is a summary of the data used to assign intensities according to the Modified Mercalli scale. The intensity assigned to the effects of the strongest shaking was chosen to be representative of the area in general. Hence, in Marshfield, even though three accounts of the shaking correspond to an intensity III and one account corresponds to an intensity IV, it is the intensity IV that is chosen to represent the area. This procedure is based upon the rationale that criteria for low intensities will always be manifest in earthquakes of greater intensity. Two accounts in Portland justify an intensity VII. However, along with these are accounts assignable to an intensity as low as II. The intensity VII obviously must be assigned to Portland.

The Portland Earthquake

Two locations which reported having felt the earthquake are no longer in existence. Cascade Locks on the Columbia River closely approximates the former location of the Cascades of 1877. The Cascades was actually a geographical feature produced by natural obstructions along the Columbia River (McArthur, 1952). In 1875 plans were made for construction of locks to facilitate passage around the Cascades. In 1878 work began on the project. The construction work was completed on November 5, 1896, and the community that had formed during the 18 years of construction was formally named Cascade Locks. In 1938 the locks were inundated by the construction of the Bonneville Dam. The town, however, remains on the shore of the lake today.

Marshfield, in Clackamas County, is no longer on maps of Oregon. In the 1876 first edition of Rand McNally and Company's "Business Atlas of the Great Mississippi Valley and Pacific Slope", Marshfield is located southeast of Portland approximately 12 miles (fig. 1).

The times that the earthquakes were felt at each of the various locations are critical in obtaining epicentral location, but unfortunately the times reported are dubious, except for possibly one. Note in the original accounts that the time of the occurrence at Marshfield is stated as "1:45 precisely, Stone's time." In an effort to determine exactly what was meant by "Stone's time," it was found that Ormond Stone, an American astronomer was assistant at the U.S. Naval Observatory in Washington from 1876-1880. It appears plausible that someone in Marshfield may have confirmed the time of the earthquake occurrence by comparing their clock's time with that of the Naval Observatory and simply made reference to it as "Stone's time." In any case, the reported times have not been regarded as credible due to the uncertainty inherent in local time keeping practices of the late 1800's.

The two shocks separated by a few seconds reported at Portland and Marshfield were probably P and S wave arrivals, respectively, the shear wave causing the most damage. The cause of the three shocks felt at Hubbard can only be ascribed to some unknown local interference of the earthquake waves.

The fact that at all locations the waves were noticed to pass from north to south lends credibility to this observation; however, the lack of more reliable occurrence times prohibits using this information to obtain epicentral location.

The most reliable criterion to use in locating the epicenter is the damage reports. It is apparent from the reports that the southern portion of Portland felt the greatest intensity. This may be due to local ground conditions; however, the intensities systematically decrease in a radial pattern from Portland (fig. 2) indicating that Portland is the epicentral location.

The Cascades Earthquake

The original account from Cascades clearly states that a shock was felt there at 9:00 a.m. October 12, 1877. Apparently the quake produced no damage. Since this earthquake was not reported as felt at other localities it can only be assumed to be a small local event (M.M. = III) with its epicenter located at Cascades.

CONCLUSION

Two earthquakes occurred in northern Oregon on October 12, 1877. The first event occurred at the Cascades (now Cascade Locks), Oregon, at approximately 9:00 a.m. The shock was not reported felt at any other locality and since no damage was reported a Modified Mercalli intensity of III is consistent with the historical account. The second event occurred at Portland at approximately 1:53 p.m. on October 12, 1877. Two chimneys were toppled and a stove was "knocked from its moorings and overturned," indicating a Modified Mercalli intensity of VII.

Table 1.--Modified Mercalli intensities assigned to felt reports of the October 12, 1877, 1:53 p.m.
Portland earthquake

Location	Observation	Modified Mercalli Int.	M.M. Int. for Area
Portland	1) People rush into street	VI	VII
	2) Felt indoors	III	
	3) Animals disturbed	II	
	4) Direction estimated	III-IV	
	5) Two chimneys overthrown	VII	
	6) Stove "knocked from its moorings" and overthrown	VI-VII	
Marshfield	1) Rattled windows	IV	IV
	2) Rattled loose or moveable objects	IV	
	3) Felt indoors	III	
	4) Direction estimated	III-IV	
	5) Estimated length of time of sharing	III	
Hubbard	Rattled household crockery	IV	IV
Cascades	1) "The last (shock) very heavy"	III-V	III-V
	2) Direction estimated	III-IV	
Columbia River	1) "Very distinct at points down the the Columbia	III-V	III-V
Puget Sound	Felt	II	II
The Dalles	Not felt	<II	Not felt
Salem	Not felt	<II	Not felt

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