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MONITORING OF AN ACTIVE FAULT NEAR LILLIWAUP,
MASON COUNTY, WASHINGTON

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One criterion for estimating seismic (earthquake) risk in an area is the presence of active or potentially active faults. These tectonic features are related to large-scale stress and strain in the earth's crust, and can be considered to be the origins of future earthquakes in an area. An active fault is one that has moved within historic times, or one where geologically young (last 10,000 years, Holocene Epoch) deposits have been displaced by motion along the fault. A potentially active fault is one along which movement has occurred during the Pleistocene Epoch (10,000 years to about 1.5 million years ago) (Wesson and others, 1972; Cluff and others, 1972; McEuen and Pinckney, 1972).

An important part of a geologic hazard investigation includes a search for faults and a determination of the age of latest displacement along the faults. Within the limits of the preserved geologic record, the relative time of movement of each fault can be approximated from stratigraphic and/or topographic relations, and the ages of latest displacement along individual faults compared. Those faults with recent displacements can be considered more likely to be active.

Although active faults are commonly observed in California, proof of the existence of active faults in the Puget Lowland is rare. Firm evidence for an active fault near Lilliwaup (fig. 1) was obtained in the summer of 1973, after a trench was
excavated across the fault trace (Carson, R. J., 1973). The trench exposed offset materials, the youngest of which is probably 15,000 years old. Therefore, movement along the fault occurred sometime during the last 15,000 years. This motion resulted in a scarp which dammed Lilliwaup Creek, forming Price Lake. One radiocarbon date obtained using wood from the bottom of the lake indicates that displacement occurred about 1,100 years ago.

The fault is now being thoroughly investigated by the Washington Division of Geology and Earth Resources; however, its existence has been suspected since the early 1940's when it was observed by J. E. Sceva during U.S. Geological Survey investigations. At that time, clear-cutting of the forest revealed the fault trace. U.S.G.S. aerial photographs taken in 1939 show the fault trace clearly, as well as another fault parallel to it (fig. 2). Aerial photography in 1972 does not reveal the fault traces, because of the second-growth forest.

A direct method of determining how active a fault is, and what forces may be acting upon the rocks, is to measure accurately any movement along the fault trace. In order to ascertain actual movement along the fault should it occur in the future, it is necessary to monitor points on either side of the trace. This was accomplished by setting six concrete monuments deep in the ground, in a straight line, three on each side of the fault (fig. 3).

Permanent marks on the brass caps of the monuments define a straight line across the fault. In view of the accuracy of the transit used in the survey, 0.016°, lateral (strike slip) motion of 1 centimeter or greater should be detectable.

Vertical motion along the fault will be checked by observing changes in relative heights between monuments. The difference in heights between monuments
was known at the time of the initial survey to within plus or minus 0.01 foot (approximately 1/2 cm). Any future vertical offset of greater than 1/2 cm should be detectable.

In the event that a major offset occurs, possibly related to a "felt" earthquake (Richter magnitude 3 to 4 and larger), it would be of interest to determine the motion of the faulted materials relative to sea level. An absolute motion such as this must be monitored using bench marks (known elevations above mean low sea level). To do this, one monument was chosen as an onsite bench mark, and its elevation determined using a microaltimeter, accurate to 1 foot of altitude. Base elevation was set at the nearest bench mark. In order to determine absolute fault movement, a vertical fault displacement of about 1 meter or greater will be necessary.

If movement occurs along the fault, it may occur imperceptibly slow as fault creep (slow, undetected movement), or rapidly, generating an earthquake. In either case, accurate monitoring of recent faulting provides data useful in the understanding of the forces generating earthquakes in the Puget Lowland.
FIGURE 1.—Index map showing the location of the fault traces and the photographic coverage shown in Figure 2.
FIGURE 2. — Stereopair of aerial photographs showing fault traces (U.S. Geological Survey, GS-J6-31, 32; flight date September 9, 1939).
FIGURE 3.—Fault survey configuration showing (top) plan view, and (bottom) profile.
SELECTED REFERENCES


