STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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# EARTHQUAKE-HAZARD GEOLOGY MAPS OF THE PORTLAND METROPOLITAN AREA, OREGON: TEXT AND MAP EXPLANATION

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# EARTHQUAKE-HAZARD GEOLOGY MAPS OF THE PORTLAND METROPOLITAN AREA, OREGON

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## ABSTRACT

As part of an earthquake hazard reduction program for northwestern Oregon, earthquake-hazard geology maps have been produced for eight 1:24,000 map sheets covering most of the Portland metropolitan area. The maps are based on new and existing geologic mapping and interpretation of several thousand boring logs. The maps depict the distribution and thickness of potentially responsive or liquefiable Quaternary sediments, other Quaternary and bedrock geologic units, faults, and contoured depth to basement data. Four units have been identified as potentially responsive or liquefiable. These are Quaternary catastrophic flood sediments (Qff), Quaternary alluvium (Qal), artificial fill (Qaf), and loess (Ql). Units Qff and Qal are commonly 30-60 ft thick and have sufficiently regular thickness to isopach. Units Ql and Qaf are locally thick but have wide variability in thickness and have not been isopached.

The northwest-trending Portland Basin is a flat-bottomed basin with faulted southwestern and northeastern margins. It reaches a maximum depth of about 1,600 ft. The northwest-trending Tualatin Basin is a gentle syncline, with faulting along its northeastern and eastern margins. The Tualatin Basin reaches a maximum depth of 1,500-1,600 ft. There are faulted or folded structural highs within both basins.

The Portland Hills (Tualatin Mountains) are a northwest-trending zone of folded and faulted basement rocks that separate the Portland and Tualatin Basins. Northwest-trending anticlines of the Portland Hills are cut by parallel and transverse high-angle faults and by southwest-dipping thrust faults.

Although numerous northwest- and northeast-trending faults have been mapped in the area, none have yet been shown to cut Holocene deposits. Some faults do cut Pleistocene rocks.

## INTRODUCTION

In 1987, the Oregon Department of Geology and Mineral Industries (DOGAMI) began a five-year program of earthquake hazards assessment for the Portland metropolitan area with funding provided by the U.S. Geological Survey (USGS) through the National Earthquake Hazard Reduction Program (NEHRP). In recognition of the importance of local geology in assessing earthquake hazards, a mapping program that has two major goals has been carried out. The first goal is to identify faults that may cut young geologic deposits, and the second is to map the distribution and thickness of fine-grained unconsolidated sediments that may amplify ground shaking or liquefy during an earthquake. The project was based on compilation of existing maps; new surface mapping by the author, M.H. Beeson, and T.L. Tolan; and examination and interpretation of 5,000-10,000 borehole logs by the author. The resultant mapping covers the Beaverton, Gladstone, Hillsboro, Lake Oswego, Linnton, Mount Tabor, Portland, and Scholls 1:24,000 sheets. The maps depict all major geologic units and identify the Quaternary sedimentary units with high earthquake-hazard potential. Where sufficient data exist, the thickness of Quaternary sediments with high potential for earthquake hazard is depicted with isopach lines. The maps also depict contoured depth to basement data and faults inferred from subsurface data. The subsurface data compiled on the Portland, Linnton, Mount Tabor, and Gladstone sheets in this report are available as a dBase III+ computer file on disc from DOGAMI (PDX 489). The subsurface data for the remaining sheets have not yet been released.

All of the area covered in this report has been previously mapped at a variety of scales. The earliest map covering the area in detail was a reconnaissance map by Treasher (1942) at a scale of 1:62,500. This was followed by a detailed map at the same scale by Trimble (1963). Several subsequent maps have involved compilation of existing surface data with water-well data (Mundorff, 1964; Hart and Newcomb, 1965; Hogensen and Foxworthy, 1965). The southwestern part of the map area was first mapped in detail by Schlicker and Deacon (1967), and the Gladstone and Lake Oswego sheets were compiled at 1:24,000 by Schlicker and Finlayson (1979). Parts of the map area have been included in a 1:100,000-scale compilation by the Washington Department of Geology and Earth Resources (Phillips, 1987). Previous published mapping for each sheet in this report is summarized in Table 1.

The mapping presented in this report differs from the previous mapping in varying degrees. On some sheets (Gladstone), there are significant changes in stratigraphy and structure. Other areas (Hillsboro, Scholls) are little

Table 1. Previously published mapping

Hillsboro Quadrangle
Hart and Newcomb, 1965; Schlicker and Deacon, 1967; Phillips, 1987.

Linnton Quadrangle
Trimble, 1963; Hart and Newcomb, 1965; Schlicker and Deacon, 1967; Phillips, 1987.

Portland Quadrangle
Treasher, 1942; Trimble, 1963; Mundorff, 1964; Hogenson and Foxworthy, 1965; Phillips, 1987.

Mount Tabor Quadrangle
Treasher, 1942; Trimble, 1963; Mundorff, 1964; Hogenson and Foxworthy, 1965; Phillips, 1987.

Scholls Quadrangle
Hart and Newcomb, 1965; Schlicker and Deacon, 1967.

Beaverton Quadrangle
Hart and Newcomb, 1965; Schlicker and Deacon, 1967.

Lake Oswego Quadrangle
Treasher, 1942; Trimble, 1963; Hart and Newcomb, 1965; Hogenson and Foxworthy, 1965; Schlicker and Finlayson, 1979; Beeson and others, 1989.

Gladstone Quadrangle
Treasher, 1942; Trimble, 1963; Hogenson and Foxworthy, 1965; Schlicker and Finlayson, 1979.

changed from the previous mapping. Significant departures from the previous mapping occur only where there is good field or subsurface evidence for the change.

## STRATIGRAPHY AND NOMENCLATURE

### Introduction

The stratigraphy of the sedimentary rocks that fill the Portland and Tualatin Basins is still very poorly understood, and the nomenclature of these units is an unresolved issue. The nomenclature and stratigraphy used in this report are presented in Table 2. Departures from previous nomenclature (Trimble, 1963; Schlicker and Deacon, 1967; Beeson and others, 1989) are noted in Table 2; all other previous nomenclature has been retained. Changes from the previous nomenclature are explained below. Nomenclature for the volcanic rocks of the region follow Beeson and others (1989), except that Columbia River Basalt Group rocks are undifferentiated in this report.

### Troutdale Formation and Sandy River Mudstone equivalent

Trimble (1963) mapped the pre-Quaternary sediments that fill the Tualatin Basin as "Troutdale Formation and Sandy River Mudstone equivalent." Schlicker and Deacon (1967) differentiated the lowermost units of the basin fill as the Helvetia Formation. The sedimentary basin fill is rarely exposed, but cuttings and logs from water wells indicate that the fill consists predominantly of quartzo-micaceous siltstone, claystone, and fine sandstone with rare gravel interbeds. These siltstones have more in common with the Sandy River Mudstone of Trimble (1963) than with the Troutdale Formation gravels (unit QTg) and may be related to the former. The sediments are mapped in this report as a Sandy River Mudstone equivalent (unit QTs). Trimble (1963) mapped some siltstones near Bonny Slope (Linnton Quadrangle) as Sandy River Mudstone. For the purpose of this report, these sediments are included with unit QTs.

### Troutdale Formation

The term "Troutdale Formation" was used by Trimble (1963) to describe Pliocene gravels and subordinate sandstone and siltstone that overlie the Sandy River Mudstone in the Portland Basin. The Troutdale Formation of Trimble was informally subdivided by Tolan and Beeson (1984) into an ancestral Columbia River facies (containing clasts exotic to the Portland Basin and adjacent Cascade Ranges) and a Cascadian stream facies (lacking clasts exotic to the Portland Basin or Cascade Ranges). Tolan and Beeson further subdivided the ancestral Columbia River facies in the Columbia River Gorge into an upper member (containing clasts

Table 2. Stratigraphy and nomenclature of Neogene sediments in the Portland and Tualatin Basins

<table>
<tr><td rowspan="8">CENOZOIC</td><td rowspan="7">QUATERNARY</td><td rowspan="2">HOLOCENE</td><td colspan="2">Artificial fill (unit Qaf)</td></tr>
<tr><td colspan="2">Alluvium (unit Qal)</td></tr>
<tr><td rowspan="5">PLEISTOCENE</td><td colspan="2">Catastrophic flood deposits (units Qff, Qfc, Qfch)--coarse, fine, and channel facies<br>[Includes terrace, sand and silt, and lacustrine deposits of Trimble (1963) and lacustrine sand and gravel and Willamette Silt of Schlicker and Deacon (1967)]</td></tr>
<tr><td colspan="2">Clackamas River terrace surface (units Qt1, Qt2)<br>[Includes Estacada Formation of Trimble (1963)]</td></tr>
<tr><td colspan="2">Loess (unit Ql)<br>[Includes upland silt of Schlicker and Deacon (1967) and undifferentiated sediments of Beeson and others (1989)]</td></tr>
<tr><td>Troutdale Formation (unit QTg)<br>[Includes Gresham and Walters Hill Formations of Trimble (1963) and unnamed conglomerate of Beeson and others (1989)]</td><td rowspan="3">Sandy River Mudstone equivalent (unit QTs)<br>[Includes Troutdale Formation and Sandy River Mudstone equivalent of Trimble (1963), Helvetia Formation of Schlicker and Deacon (1967), and undifferentiated sediment of Beeson and others (1989)]</td></tr>
<tr><td>Sandy River Mudstone (unit Tsr)</td></tr>
<tr><td>TERTIARY</td><td>PLIOCENE</td><td></td></tr>
</table>

of local high-alumina basalts) and a lower member (lacking clasts of high-alumina basalt). Within the Portland basin, the discrimination between the two facies and the two members is difficult on an outcrop-by-outcrop basis. Resolution of the stratigraphic and facies relations of the Troutdale Formation is beyond the scope of this report. For the purposes of this report, all of these gravels and associated sediments are mapped as undifferentiated Troutdale Formation (unit QTg).

**Gresham Formation, Walters Hill Formation**

The Walters Hill Formation was defined by Trimble (1963) as "conglomerate, sandstone, and mudflow deposits...of questionable origin and age." The Gresham Formation was defined by Trimble (1963) as gravel and mudflow deposits forming terraces in the Clackamas and Sandy River valleys and representing alluvial backfill of those valleys. The rocks mapped as Gresham Formation north and south of the lower Clackamas River consist of andesite-dacite-basalt conglomerates with lithic-feldspathic sand and silt matrix. The conglomerates also have interbeds of lithic-feldspathic sand and silt and volcanic ash and debris-flow material. These rocks can be traced continuously in the subsurface beyond the Clackamas drainage into outcrops mapped by Trimble (1963) as Troutdale Formation and are clearly bedrock, not alluvial backfill. Similar gravels and sands originally mapped by Trimble (1963) as Walters Hill Formation at Mount Scott are continuous in the subsurface with Gresham Formation rocks. In this report, rocks mapped by Trimble as Gresham or Walters Hill Formation (Gladstone Quadrangle) are included in unit QTg (Troutdale Formation).

**Lacustrine deposits, sand and silt deposits, terrace deposits**

Sand, gravel, and silt deposited by late Pleistocene outburst floods from glacial Lake Missoula cover much of the lower lying parts of the map area. These deposits were originally divided by Trimble into a gravel, sand, and clay facies of lacustrine deposits, younger sand and silt deposits, and terrace deposits occupying an abandoned channel of the Clackamas River. The exact ages and stratigraphy of the flood deposits are very poorly understood in the map area, and there is considerable disagreement as to whether the deposits represent a few floods, or dozens (Baker and Nummedal, 1978; Waitt, 1985). For this report, all of the above deposits are mapped as facies of the catastrophic flood deposits, following Beeson and others (1989). The lacustrine gravels are mapped as the coarse facies, and the lacustrine sands and clays and the sand and silt deposits are mapped as the fine facies. The terrace deposits may occupy an ancestral channel of the

Clackamas River; however, the head of the channel is currently 70 ft above the Clackamas River flood plain and is covered with catastrophic flood sediments. This implies that the Clackamas River has not occupied the ancestral channel since the catastrophic floods, and the sediments in the channel were deposited by the floods. The deposits in the channel are complexly layered silts, sands, and gravels and have been mapped as the channel facies of the flood deposits.

## HIGH-POTENTIAL EARTHQUAKE-HAZARD UNITS

Poorly consolidated Quaternary surficial deposits commonly amplify earthquake ground motions or fail due to liquefaction during major earthquakes. These phenomena enhanced damage in many recent earthquakes such as Mexico City in 1985 (Seed and others, 1988), Armenia in 1988 (Borcherdt and others, 1989), and in San Francisco in 1989 (Pflaker and others, 1989). Poorly consolidated sands, silts, or clays overlying more competent materials are most likely to amplify ground shaking. Poorly consolidated saturated sands and silts are most likely to liquefy during strong ground shaking. Both classes of materials are widely distributed in the Portland area, as originally recognized by Schlicker and others (1964). The frequency and amplitude of ground shaking amplification at any site will depend on the thickness and seismic velocity profile of the sediment column at the site, and prediction of these effects is beyond the scope of this report. Earthquake-induced liquefaction of sediments at any site will depend on the strength and duration of local ground shaking as well as hydrologic conditions at the site and cannot be reliably predicted from this report alone. Earthquake-induced landsliding or reactivation of existing landslides may present a significant hazard. However, mapping of unstable slopes or existing landslides is beyond the scope of this report.

Four geologic units in the Portland metropolitan area are potentially responsive and/or liquefiable. They are as follows:

1. Quaternary loess (unit Ql).

2. Fine-grained sediments deposited by late Quaternary catastrophic floods (unit Qff).

3. Quaternary fine-grained alluvium (unit Qal).

4. Sand, silt, and heterogeneous fills (unit Qaf).

Of these four units, only units Qff and Qal are sufficiently uniform in thickness to isopach. The general nature and distribution of these units are described below.

For more detailed geologic descriptions of these units see the section entitled "Map Explanation."

**Unit Ql (loess)**

Unit Ql consists of loessal silt that mantles most slopes higher than 300 ft above sea level. Unit Ql may exist below this elevation, but it is difficult to distinguish between silts of unit Ql and unit Qff, and the lower boundary of unit Ql is mapped on the assumption that it is either buried by unit Qff or has been eroded by catastrophic flooding below 300 ft above sea level. Previous workers (Trimble, 1963; Schlicker and Deacon, 1967; Lenz, 1977) have depicted unit Ql as thicker on ridge crests and thinner on valley walls and floors in most drainages. Field work for this study indicates that the valley walls of minor drainages are typically covered with either unit Ql or colluvium derived from unit Ql and that exposure of the underlying bedrock units is rare except in stream channels. Limited subsurface data indicate that unit Ql is widely variable in thickness, with maximum values of 70-100 ft reported along the crest of the Portland Hills, 20-40 ft common along the northeast and southwest slopes of the Portland Hills, and substantially thinner deposits present on the Chehalem Mountains, Mount Scott, and Cooper and Bull Mountains. As a result of the variable distribution and thickness of unit Ql, it has been mapped as a pattern over the underlying bedrock units, indicating the areas in which significant (5 ft or greater) loess can be expected to occur. Unit Ql is notoriously landslide-prone when saturated and represents a significant earthquake-induced landslide hazard.

**Unit Qff (catastrophic flood silts and sands)**

Unit Qff consists of crudely to complexly layered, poorly consolidated medium sand to silt deposited by one or more phases of catastrophic glacial outburst floods from late Pleistocene Lake Missoula. Sediments of unit Qff occur along both sides of the Willamette and Columbia Rivers, locally in the Gladstone-Oregon City area and throughout the Tualatin Basin. The thickness of unit Qff is typically 30-60 ft, with a maximum thickness in the map area of 180 ft. Unit Qff sediments were deposited beneath regionally ponded floodwaters, the highest of which reached an elevation of approximately 400 ft above sea level, based on the distribution of ice-rafted erratics (Allison, 1935). However, sediments that are clearly part of unit Qff are typically found no higher than 250-300 ft above sea level. Ponding of floodwaters to 400 ft above sea level may not have happened sufficiently often or for a sufficient length of time to allow significant sediment deposition at higher elevation. It is very difficult to distinguish unit Qff and unit Ql in all but the best outcrops; hence the contact between the two units is commonly drawn following the 300-ft contour in the absence of site-specific data.

Evidence of liquefaction is commonly observed in good exposures of unit Qff in the form of silt dikes that crosscut both bedding and earlier dikes. It is not clear whether liquefaction occurred during multiple flood events, subsequent earthquakes, or both.

**Unit Qal (Quaternary alluvium)**

Unit Qal consists of very poorly consolidated sand, silt, clay, and gravel deposited in the channels and on the flood plains of the modern Columbia and Willamette Rivers and their tributaries. In the Willamette and Columbia, sand and silt predominate, although organic material and clay are locally abundant. Limited gravel deposits occur as bars (Ross Island) or layers at the base of the section in channels. The early Holocene post-outburst flood channels of the Columbia and Willamette Rivers were cut to depths of approximately 150 ft below the present flood plain. These channels have been filled with unit Qal, apparently restricted to a maximum elevation 35 ft above modern sea level about the maximum level of historic floods. Alluvium in the Clackamas River, which drains an area of high relief in volcanic rocks of the Cascade Range, is dominantly volcaniclastic sand and gravel. Alluvium in the Tualatin River, which drains a basin filled with fine-grained sediments of unit QTs and unit Qff, is predominantly sand, silt, clay, and organic material. In both the Clackamas and Tualatin Rivers, unit Qal deposits are largely restricted to Holocene channels incised into the outburst flood sediments. Similarly, minor tributaries to all the major rivers have local deposits of alluvium, restricted to the post-outburst flood channels. Unit Qal in most minor tributaries is not depicted in this report because (1) subsurface data suggest that the unit thins rapidly away from the immediate channels, and (2) the maps are clearer without it. Detailed depictions of the lateral extent of unit Qal in minor tributaries in maps by Trimble (1963) and Schlicker and Deacon (1967) are consistent with the data collected for this study.

**Unit Qaf (artificial fill)**

Unit Qaf is widespread in developed areas along the flood plains of the Columbia and Willamette Rivers and in gullies in the downtown Portland and east Portland areas. The most common material is dredged river sand, although older uncontrolled fills contain significant thicknesses of rubble, mill ends, and sawdust. Unit Qaf is mapped only where sufficient fill has been placed to eliminate lakes, sloughs, or gullies present during the 1898 survey for the earliest topographic map of Portland (U.S. Geological

Survey, 1905). Unit Qaf was mapped by comparison of the modern map with the older map and is therefore depicted only on the Portland and Mount Tabor sheets and on part of the Linnton sheet. Fill 5- to 15-ft thick is common in the developed areas of the Columbia and Willamette flood plains, but its thickness and distribution are highly variable and cannot be accurately depicted at the scale of these maps.

The remaining geologic units on the map, Quaternary gravels and older sedimentary and volcanic rocks, typically have relatively low potential for amplification of earthquake ground motion or liquefaction. All of these units may represent an earthquake-induced landslide hazard on steep slopes or where deeply weathered.

## STRUCTURE

One of the primary goals of this program was to identify faults in the area and to determine whether any of these faults are active. Faults mapped in long-dash pattern are inferred from apparent offset of well-defined stratigraphic units, and these faults are largely confined to the Lake Oswego sheet and the southwest quadrant of the Gladstone sheet where Columbia River Basalt Group stratigraphy has been mapped in detail (Beeson and others, 1989; Beeson and Tolan, unpublished mapping). Faults mapped with dotted lines in these areas represent buried faults mapped by Beeson and others (1989). Faults represented by dotted lines on the remaining sheets are inferred on the basis of relatively abrupt changes in elevation of a single contact surface. There is clearly significant erosional relief on many of the major contact surfaces, particularly the top of the Columbia River basalt. Buried paleochannels 250-500 ft deep are present in the southeast corner of the Gladstone sheet, in the south of the Scholls and Beaverton sheets, and on the southern edge of the Lake Oswego sheet. The interpretation of any particular change in contact elevation as a fault rather than buried paleotopography is based on regional trends, neighboring structures, and geomorphology.

### Sense and amount of offset

The sense of vertical offset is generally obvious from the nature of the contact elevation or stratigraphic change. Vertical offset on many faults appears to die out or change sense along strike. The amounts of offset indicated by depth-to-bedrock contours are estimates. Exposed fault planes are rare, but subhorizontal slickensides have been found on fault planes in the Columbia River basalt in the southeast portion of the Lake Oswego sheet (M.H. Beeson, personal communication, 1989).

## Age of faulting

All of the faults mapped clearly cut the Columbia River Basalt Group (Tcr) and therefore have been active since the middle to late Miocene. Several faults cut the Pliocene Sandy River Mudstone (Tsr) and Troutdale Formation gravels (unit QTg), which are Pliocene and possibly Pleistocene. The youngest faulted rocks in the area are the upper Pliocene-Pleistocene basalt flows of unit QTb. The exact age of faulted Boring Lava flows in the map area is not yet known. A faulted flow immediately east of the southeast corner of the map area has a K/Ar age date of 612 ka ± 23 ka (Robert Duncan, personal communication, 1989). The amount of offset of this faulted flow is not known.

## Portland Hills structure

The Portland Hills (Tualatin Mountains) are a narrow northwest-trending range that rises about 1,000 ft above the basins on either side. Mapping in the Lake Oswego Quadrangle (Beeson and others, 1989) has shown the Portland Hills to be a folded and complexly faulted northwest-trending structural high of Columbia River basalt. Simple broad anticlinal folds are cut by numerous high-angle faults both tranverse and parallel to the main northwest structural axis. The structural high is also cut by several southeast-dipping thrust faults. Schlicker and others (1964) and Balsillie and Benson (1971) suggested the that the Portland Hills were the result of uplift along a single Portland Hills Fault. The mapping of Beeson and others (1989) indicates that the Portland Hills may best be considered a major fault zone, of which the Portland Hills Fault is only one strand. More detailed mapping of the Portland Hills on the Portland Quadrangle is scheduled for publication by DOGAMI in 1990.

## Basin structures

The large-scale structure of the Portland and Tualatin Basins is fairly well understood, and this report adds only detail to the models previously proposed (Hart and Newcomb, 1965; Hammond and others, 1974; Swanson and others, 1990).

The Tualatin Basin is a broad northwest-trending syncline. Faulting along the basin margin appears to be restricted to the eastern margin of the basin where it meets the Tualatin Mountains. Intrabasin faulting occurs along the north and east edges of the Bull and Cooper Mountain anticlines. Between West Union and North Plains, an elongate bedrock high in the subsurface may be a buried fault or upwarp.

The Portland Basin is clearly fault bounded along its western edge from the Clackamas River as far north as downtown Portland. A fairly abrupt step of several hundred feet occurs in the top of the basement (units Tcr and Twh) as far north as downtown Portland. Northwest of downtown Portland, this abrupt step is poorly defined or absent. However, the unusually steep and straight front of the Portland Hills and gravity data (Beeson and others, 1975) imply a continuation of a fault in this area, as suggested by Schlicker and others (1964) and Balsillie and Benson (1971). The eastern edge of the Portland Basin is outside the area of this report; however, it appears to also be fault bounded with an abrupt step in the top of the basement along much of its margin (Mundorff, 1964; Davis, 1986; Ken Lite and Rod Swanson, personal communication, 1990). Data on the depth to bedrock are absent in the center of the basin, but limited gravity data (Perttu, 1980) and proprietary seismic data suggest that the top of the basement is fairly flat through the center of the basin and about 1,600 ft deep. A northwest-trending basement high (Hogenson and Foxworthy, 1965; Swanson and others, 1990; Madin, unpublished mapping) occurs south and east of the map area (Damascus Quadrangle). Gravity data and limited subsurface data suggest that this high extends to the northwest beneath Mount Scott, Kelly Butte, Mount Tabor, and Rocky Butte. The amount of structural relief on this buried feature has been estimated at 300 ft based on gravity data of Perttu (1980). Faulting identified on the Mount Tabor sheet near Rocky Butte and Mount Tabor is probably associated with this feature. There are no depth to basement data available for the Mount Tabor or Gladstone sheets, except along the westernmost edges of both. Depth to bedrock on the remainder of these sheets is a matter of conjecture, and contours have not been drawn.

## ACKNOWLEDGMENTS

The following organizations contributed immensely to this project by allowing access to their files of subsurface data: City of Portland Bureau of Buildings, Oregon Department of Transportation-Region 1 Office and Bridge Division, U.S. Geological Survey Water Resources Division, Port of Portland, Dames and Moore, Shannon and Wilson, Rittenhouse-Zeman Associates, Kelly-Strazer Associates, L.R. Squier Associates, and Geotechnical Resources Inc. Dr. M.H. Beeson and Mr. T.L. Tolan provided unpublished geological mapping for the southwest corner of the Gladstone sheet. Evan Thoms and Tom Popowski assisted in field work in the Washington County areas. Reviews by Rod Swanson, Bob Deacon, Marv Beeson, Ken Robbins, and George Priest were greatly appreciated. Paul Staub provided valuable cartographic assistance. This work was funded by U.S. Geological Survey Cooperative Agreement No. 14-08-0001-A0512 as part of the National Earthquake Hazard Reduction Program.

## MAP EXPLANATION

**Qaf** **Artificial fill (Recent)**--Sand and silt fill that locally includes rock, gravel, rubble, sawdust, and mill ends

**Qal** **Alluvium (Quaternary)**--River and stream deposits of silt, sand, clay, and gravel composed of mixed lithologies; largely confined to channels and flood plains of the major rivers and valley bottoms of tributary streams

**Catastrophic flood deposits (Pleistocene)**--Boulders, gravels, sandy gravels, and sands containing high percentages of Columbia River basalt clasts and representing high-energy, subfluvial deposition during catastrophic floods caused by the repeated failure of the glacial ice dam that impounded glacial Lake Missoula (see Bretz and others, 1956; Baker and Nummedal, 1978; Waitt, 1985; Allen and others, 1986). Date of most recent catastrophic flood is estimated to be 15,500 to 13,000 years B.P. (Mullineaux and others, 1978; Waitt, 1987; Beeson and others, 1989). Within map area, flood sediments are subdivided into three facies listed below

**Qfch** **Channel facies (Pleistocene)**--Complexly interlayered and variable silts, sands, and gravels deposited in major floodways by flood events. The channels are cut in earlier and/or contemporaneous fine and coarse flood sediments (units Qff and Qfc). The irregular post-flood surfaces of these deposits have been locally filled by bog or pond sediments and by overbank alluvium from Johnson, Kellogg, and Crystal Springs Creeks (Beeson and others, 1989)

**Qff** **Fine-grained facies (Pleistocene)**--Coarse sand to silt deposited by catastrophic floods. The finer sediments are predominantly quartz and feldspar and also contain white mica. The coarser sediments are predominantly Columbia River basalt fragments. Poorly defined beds of 1-3 ft thickness are observed in outcrop, and complex layering is recorded in boreholes. Soil development commonly introduces significant clay into the upper 6-15 ft of the deposits. The fine sediments are locally thick in the lower portions of the area and extend upslope as a mantle to a maximum elevation of about 300 ft (Beeson and others, 1989)

**Qfc Coarse-grained facies (Pleistocene)**--Pebble to boulder gravel with silt and coarse sand matrix. The coarse sediments are poorly sorted and moderately to well rounded. The coarse deposits range from openwork gravel to gravel with considerable fine-grained matrix material. Clasts are largely basalt, but other lithologies may dominate downstream from bedrock exposures (Beeson and others, 1989)

**Qt1, Qt2 Clackamas River terrace surfaces (Pleistocene)**--Erosional terrace surfaces cut by the Clackamas River across unit QTg gravels. The unit Qt2 surfaces are capped by 5-15 ft of poorly indurated sandy pebble-cobble Cascadian volcanic gravels and 1-5 ft of unit Qff. The nature of the capping sediments on the unit Qt1 surface was not observed. The unit Qt2 surfaces were previously mapped by Trimble (1963) as Estacada Formation gravels. This nomenclature has been abandoned in this report because there are clearly several terrace surfaces included in Trimble's Estacada Formation and because the terraces do not represent a significant deposit of material in this map area

**Ql Loess (Pleistocene)**--Poorly indurated brown, red-brown or gray quartzo-micaceous silt. The loess is massive and commonly contains 0.1- to 0.25-in. in diameter spherical iron oxide concretions. Modern soil development commonly produces vertical jointing, mottling with iron oxides, and significant quantities of clay in the uppermost 2-5 ft of the unit. Paleosols have also been described within the unit by Lentz (1977). The thickness of the loess ranges from traces to 100 ft. Earlier workers reported a fluvial origin for some of this material, based on the presence of laminations and scattered rounded quartzite pebbles (Treasher, 1942; Lowry and Baldwin, 1952). Lentz (1977) concluded that the silt in the Portland area was loessal in origin, a conclusion borne out by this study. It is likely that earlier workers confused water-laid sediments of similar lithology from other units with unit Ql. It should be noted that it is difficult to distinguish between unit Ql, massive sediments of units QTs or Tsr, and silts of unit Qff in all but the best exposures. The age of unit Ql is uncertain; Lentz (1977) considered the age to range between 700,000 years and 34,400 years based on relations with the Boring Lava and catastrophic flood deposits

**QTg Troutdale Formation gravels (Pliocene to Pleistocene?)**--Moderately to well-lithified conglomerates with minor interbeds of sandstone, siltstone, and claystone and volcanic ash and debris flows. The conglomerates typically consist of well-rounded pebbles and cobbles of Columbia River basalt, High Cascade and Boring high-alumina basalt, andesite, dacite, and exotic metamorphic and plutonic rocks. The sand and silt conglomerate matrix and interbeds contain varying amounts of feldspathic, quartzo-micaceous, and volcanic lithic and vitric sediment. The lithology of the sediments and ratio of conglomerate to sandstone and siltstone vary widely throughout the area. Unit QTg reaches a maximum thickness of 200-300 ft in the northeast part of the map area and is up to 900 ft thick in other parts of the Portland Basin (Swanson, 1986). Trimble (1963), Swanson (1986), and Tolan and Beeson (1984) have shown that the rocks mapped as Troutdale Formation in many parts of the Portland area are Pliocene to upper Pliocene. Unit QTg as defined here includes rocks that are interbedded with Pliocene-Pleistocene Boring Lava. Rocks mapped by Trimble (1963) as Gresham Formation and Walters Hill Formation are included in unit QTg

**QTb** **Boring Lava (Pliocene to Pleistocene)**--Light-gray to gray, diktytaxitic, olivine- (less commonly plagioclase-) phyric basalt and basaltic andesite flows erupted from a series of local vents. Eruptive activity associated with Boring Lavas built cones (e.g., Mount Sylvania, Mount Scott) composed of interstratified cinders and lava. At Rocky Butte, an intrusive body of Boring Lava has been exposed by uplift and erosion. Boring Lava flows typically display blocky to columnar jointing and, if preserved, vesicular flow tops. Thickness of unit QTb is highly variable ranging from >600 ft at a vent to <50 ft for individual flows away from the vent. Boring flows can be distinguished from older basalt units on the basis of physical appearance, stratigraphic position, lithology, and major oxide composition (Beeson and others, 1989). Age of unit QTb within the map area is upper Pliocene-Pleistocene based on limited data. Swanson (1986) reports K/Ar ages for Boring Lava of 1.33 m.y. (Rocky Butte, Mount Tabor Quadrangle) and 2.6 m.y. (Oregon City area, south of Gladstone Quadrangle). A recently dated Boring Lava flow from Damascus (east of Gladstone Quadrangle) has a K/Ar age of 612 ± 23 ka (Duncan, personal communication, 1989)

**QTs** **Sandy River Mudstone equivalent (middle Miocene? to Pleistocene?)**--Moderately to poorly lithified siltstone, sandstone, mudstone, and claystone that fill the Tualatin Basin. The unit is poorly exposed and difficult to differentiate from units Qff and Ql. Cuttings from a few deep wells consist of blue-gray and brown quartzo-micaceous silt and very fine sand. Well logs typically describe blue-gray and brown or red-brown sand and clay and rarely gravel. Deeply weathered quartzo-micaceous silts with minor amounts of Columbia River basalt-clast gravels were mapped around the margin of the Tualatin Basin as Helvetia Formation by Schlicker and Deacon (1967). These sediments appear to differ from the sediments buried in the basin only in degree of weathering and are included in unit QTs in this report. Unit QTs is 900 ft thick beneath Beaverton and reaches a maximum thickness of 1,400-1,500 ft near Hillsboro. The middle Miocene-Pleistocene age of unit QTs is constrained by its stratigraphic position above the Columbia River Basalt Group and below the Boring Lava

Tsr **Sandy River Mudstone (Pliocene)**--Moderately to poorly lithified siltstone, sandstone, mudstone, and claystone deposited in the Portland Basin. Typically blue-green to gray where fresh, weathering brown to reddish brown. The dominant mineralogy is quartzo-micaceous. Organic material is common and includes branches and logs. Volcanic ash layers and pumice sands occur locally. The rocks are commonly finely laminated and are locally ripple-laminated and cross-bedded. Local channel fills of unit QTg lithology gravels occur along the Clackamas River upstream of the map area and near Park Place just south of the Clackamas River. Unit Tsr is more than 780 ft thick in the southeast corner of the Gladstone sheet and 900 ft thick in the southwest corner of the Mount Tabor sheet. Trimble (1963) considered unit Tsr to be a lacustrine deposit, but recent examination of sedimentary structures in unit Tsr along the Clackamas River suggests a fluvial origin (C.D. Peterson and A.R. Niem, personal communication, 1989). Trimble (1963) also indicated that the unit contained an early Pliocene fossil flora

Tcr **Columbia River Basalt Group (middle Miocene)**--Miocene tholeiitic flood-basalt flows that were erupted from long linear fissure systems in northeastern Oregon, eastern Washington, and western Idaho from approximately 17 to 6 Ma (Swanson and others, 1979; Hooper, 1982). Many individual flows are known to be huge in size, often covering thousands to tens of thousands of square miles and ranging from tens to hundreds of cubic miles in volume (Tolan and others, 1989). These flows entered western Oregon via a wide gap in the northern Oregon Miocene Cascade Range (Beeson and others, 1985; Beeson and others, 1989); some flows even reached the Pacific Ocean (Beeson and others, 1979). Significant differences and variations in the geochemical, paleomagnetic, and lithological properties of Columbia River Basalt Group flows allow this series of flood-basalt flows to be formally divided into five formations (Swanson and others, 1979) and also enable these formations to be further subdivided into a host of mappable members and units (Swanson and others, 1979; Beeson and others, 1985; Reidel and others, 1989). Members and units belonging to the Wanapum and Grande Ronde Basalts, two of the five Columbia River Basalt Group formations, are present within the map area and have a collective thickness ranging up to >670 ft in the Tualatin Mountains

**Twh** **Basalt of Waverly Heights and associated undifferentiated sedimentary rocks (Eocene)**--Consists of a sequence of subaerial basaltic lava flows and associated sediments that unconformably underlie flows of the Columbia River Basalt Group. The top of unit Twh is typically marked by a deeply weathered zone (probably >30 ft thick), except where it has been scoured away either by catastrophic flood waters or by normal river downcutting. Consequently, the best exposures of this unit are found adjacent to the Willamette River in the Waverly Heights area. Flows of unit Twh are typically blocky to columnar jointed and have well-developed vesicular flow tops and bottoms. Vesicles and vugs within flow tops, as well as some joints, are commonly filled with secondary minerals. Flow morphology and the absence of intraflow structures (pillow complexes and hyaloclastites) suggest that the lava flows were emplaced subaerially. Fresh flow surfaces are typically brownish gray to black; weathered surfaces are dark gray to brownish black. In hand sample, the flows are commonly fine to medium grained and range from sparsely to abundantly plagioclase phyric, with phenocrysts and glomerocrysts that are usually <0.5 cm in size. Unit Twh flows are basaltic in composition and are similar in composition to those of the Columbia River Basalt Group. However, unit Twh flows can be distinguished from Columbia River Basalt Group flows because they do not precisely match any specific compositional type within the Columbia River Basalt Group. Two flows have yielded K-Ar dates of about 40 Ma (R.A. Duncan, personal communication, 1982). Sediments associated with unit Twh flows are not exposed, but borehole data suggest a marine environment of deposition and further suggest that these sediments underlie much of the Tryon Creek area. Thickness of this unit is not known, but it is assumed to extend to considerable depth in the map area (Beeson and others, 1989)

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STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

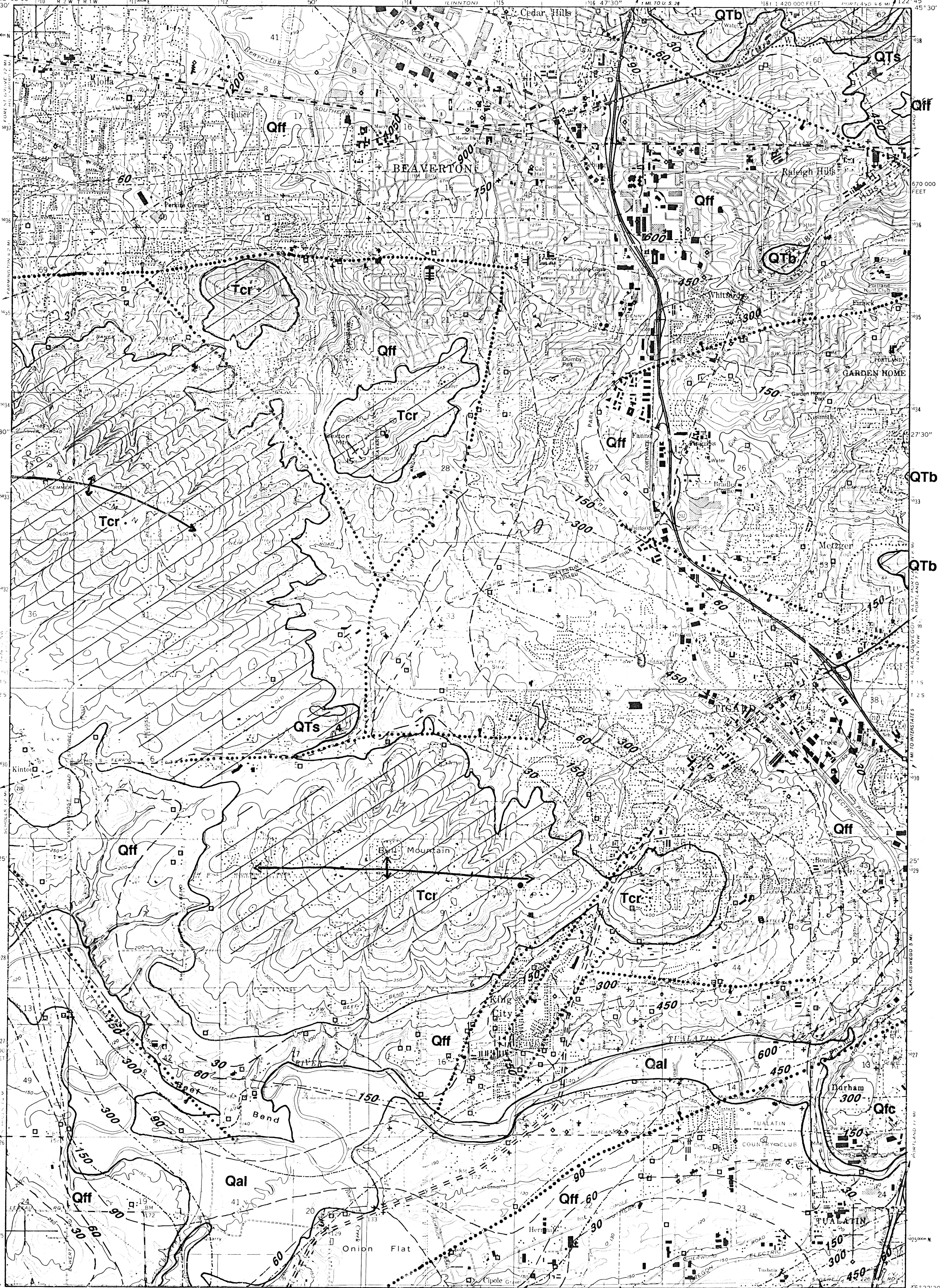
BEAVERTON QUADRANGLE
OREGON - WASHINGTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

# Open File Report 0 - 90 - 2

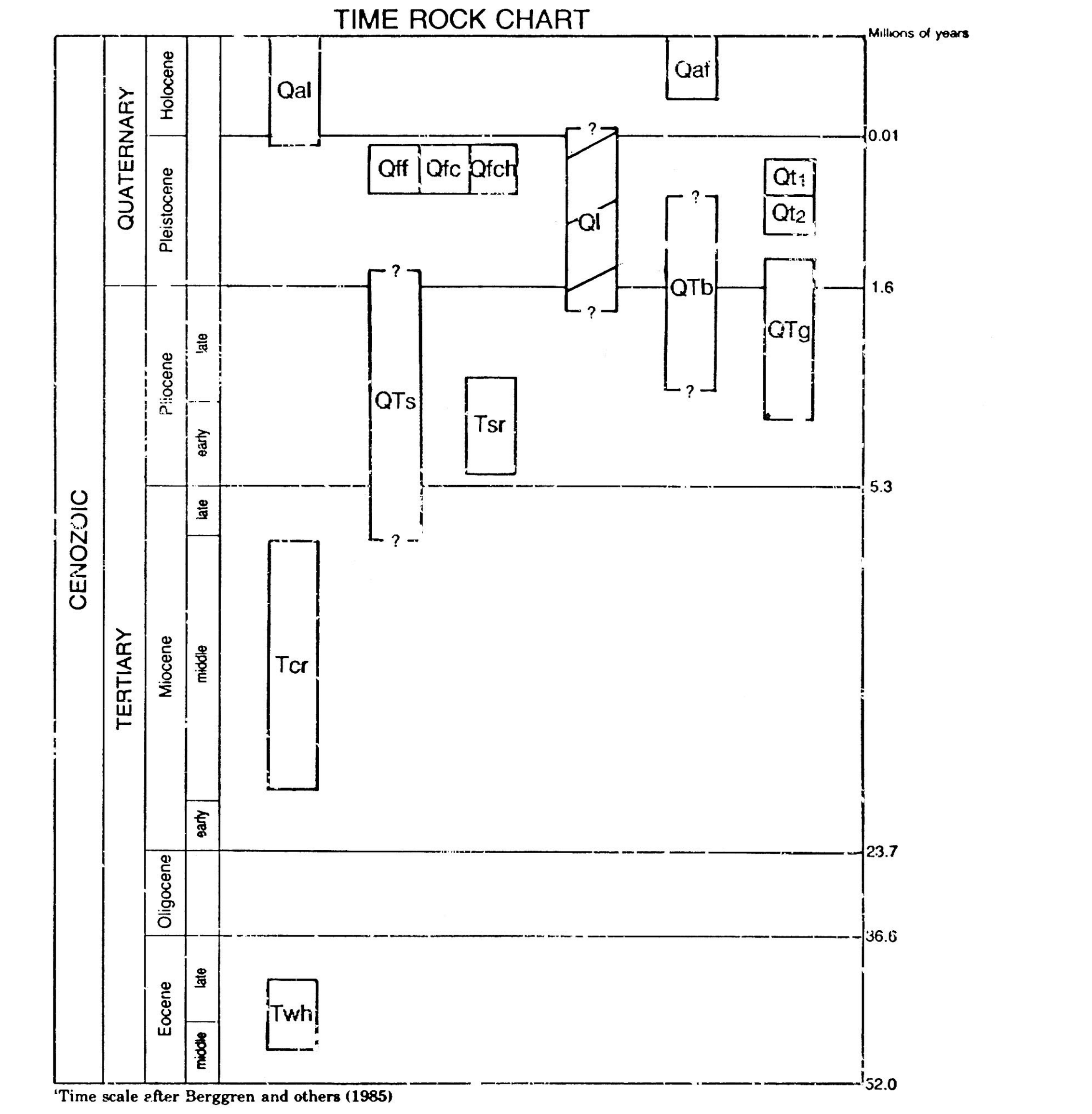
Earthquake hazard geology maps of the Portland metropolitan area, Oregon

By Ian P. Madin

Funded in part by U.S. Geological Survey Cooperative Agreement # 14-08-0001-A0512
as part of the National Earthquake Hazard Reduction Program




TIME ROCK CHART




*Time scale after Berggren and others (1985)

## GEOLOGIC UNITS

Field work completed in 1988-89

| | |
|---|---|
| Qaf | Artificial fill (Recent) |
| Qal | Alluvium (Quaternary) |
| | Catastrophic flood deposits (Pleistocene) |
| Qfch | Channel facies (Pleistocene) |
| Qff | Fine-grained facies (Pleistocene) |
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| Tcr | Columbia River Basalt Group (middle Miocene) |
| Twh | Basalt of Waverly Heights and associated undifferentiated sedimentary rocks (Eocene) |

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Area overlain by >5 ft of unit Ql

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Fault – inferred from offset of single contact surface; ball and bar on downthrown side. (On Lake Oswego Quad and southwest corner of Gladstone Quad, buried fault inferred from offset of well-defined stratigraphy)

Thrust fault – inferred from offset of well-defined stratigraphy; teeth on upper plate

Anticlinal axis

30 Isopach on units Qff and/or Qal – 30-ft isopach interval

150 Depth to basement contour – 150-ft interval

5 Strike and dip of bed

Subsurface data points:

- ◇ Hole bottoms in units Qff, Qal or Ql
- + Hole bottoms in unit Qfc, Qfch, QTg, QTs, QTb, or Tsr
- □ Hole bottoms in unit Tcr or Twh

For detailed description of geologic units, see accompanying text

Mapped, edited, and published by the Geological Survey

Control by USGS and NOS/NOAA, and State of Oregon

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1952. Field checked 1954
Revised from aerial photographs taken 1960. Field check 1961

Projection and 10,000-foot grid ticks: Oregon coordinate system, north zone (Lambert conformal conic)
1000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue. 1927 North American datum
To place on the predicted North American Datum 1983 move the projection lines 23 meters north and 94 meters east as shown by dashed corner ticks

Red tint indicates areas in which only landmark buildings are shown
Fine red dashed lines indicate selected fence lines

UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

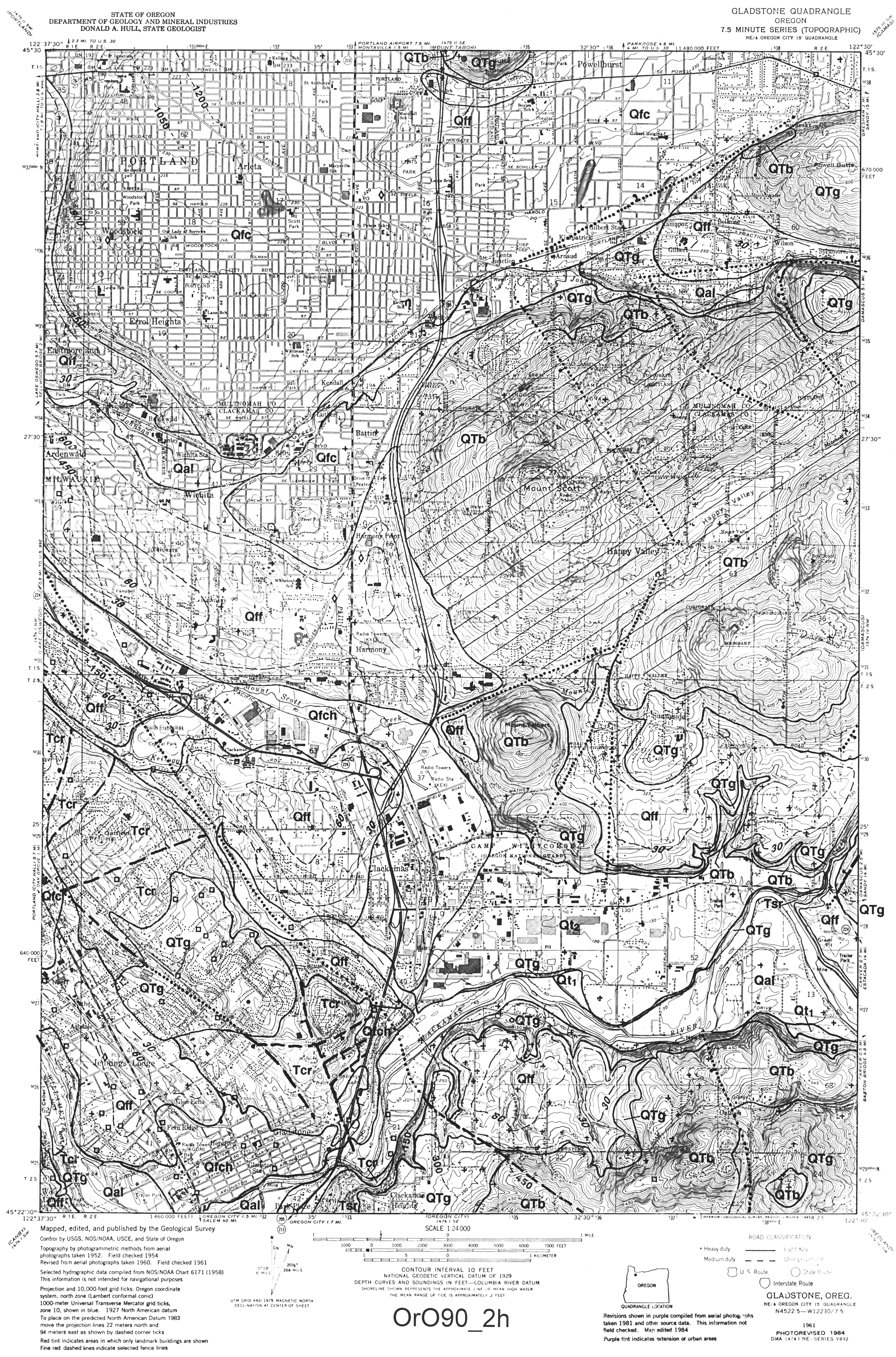
OrO90_2f

QUADRANGLE LOCATION

Revisions shown in purple compiled by Geological Survey from aerial photographs taken 1981 and other sources
This information not field check. Map edited 1984
Purple tint indicates extension of urban areas

ROAD CLASSIFICATION
Heavy duty — Light duty
Medium duty — Unimproved dirt
Interstate Route — U.S. Route — State Route

BEAVERTON, OREG.
NE 4 BEAVERTON 15' QUADRANGLE
45122-D7-TF-024
1961
PHOTOREVISED 1984
DMA 1174 IV NE-SERIES V892

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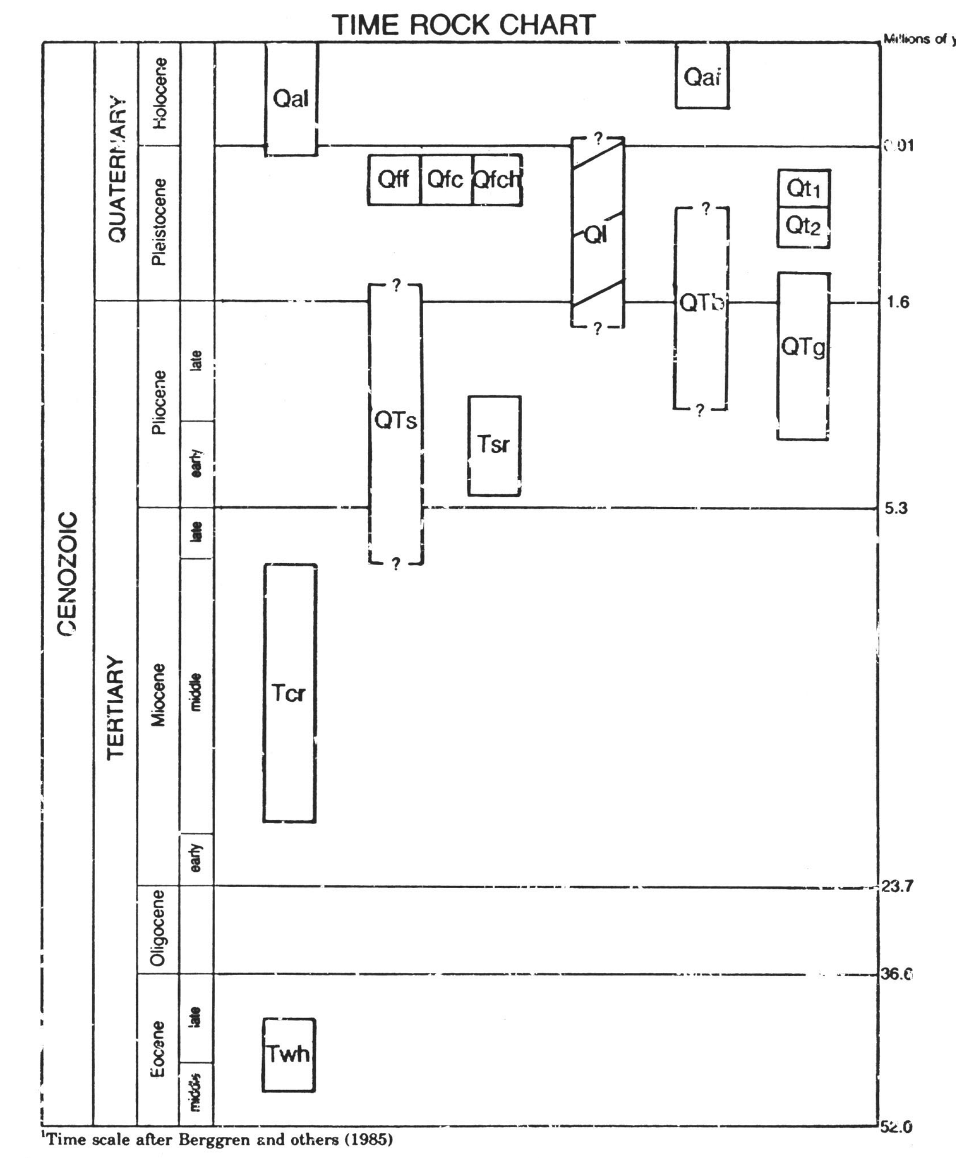


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- 5 — Strike and dip of bed
- Subsurface data points:
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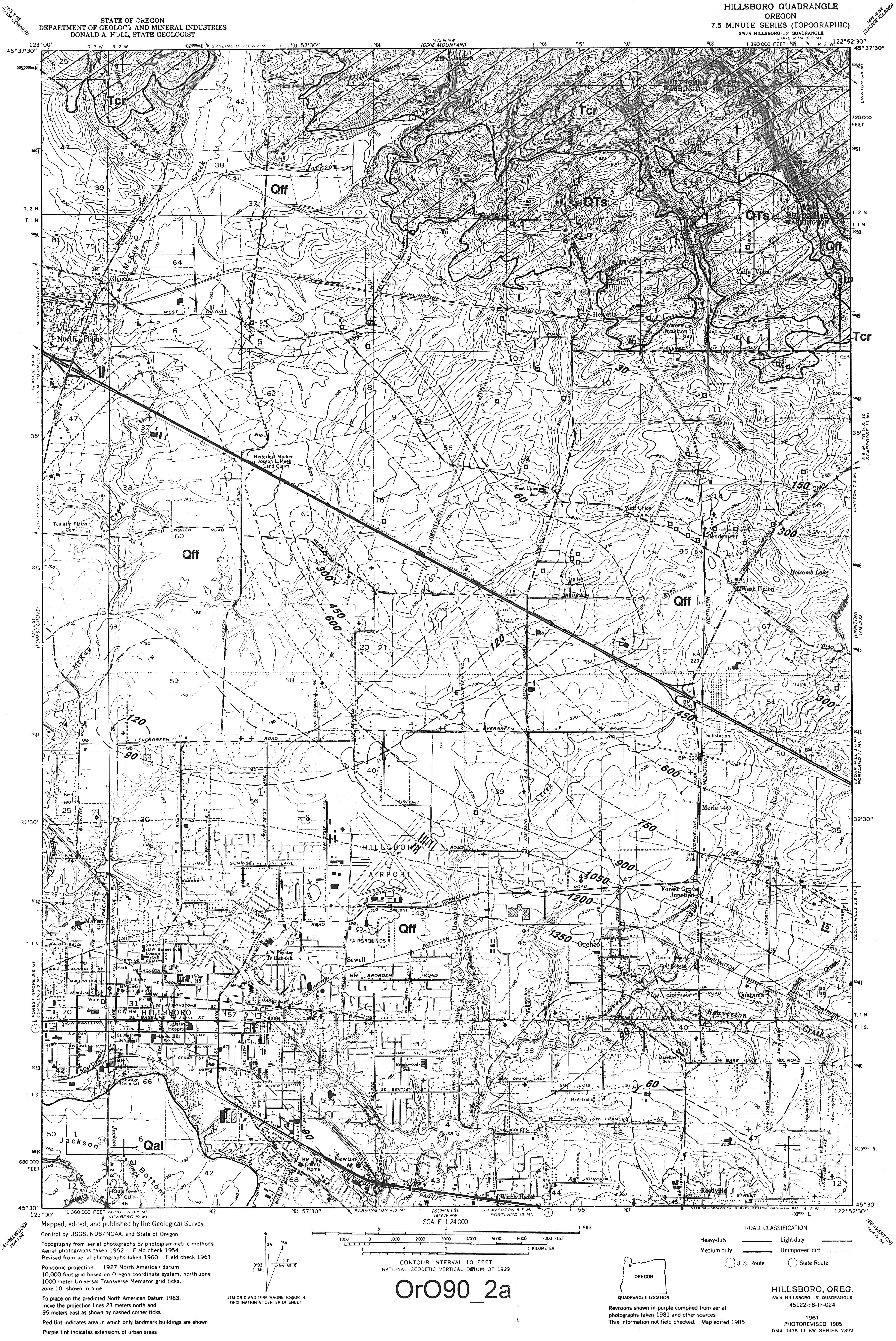


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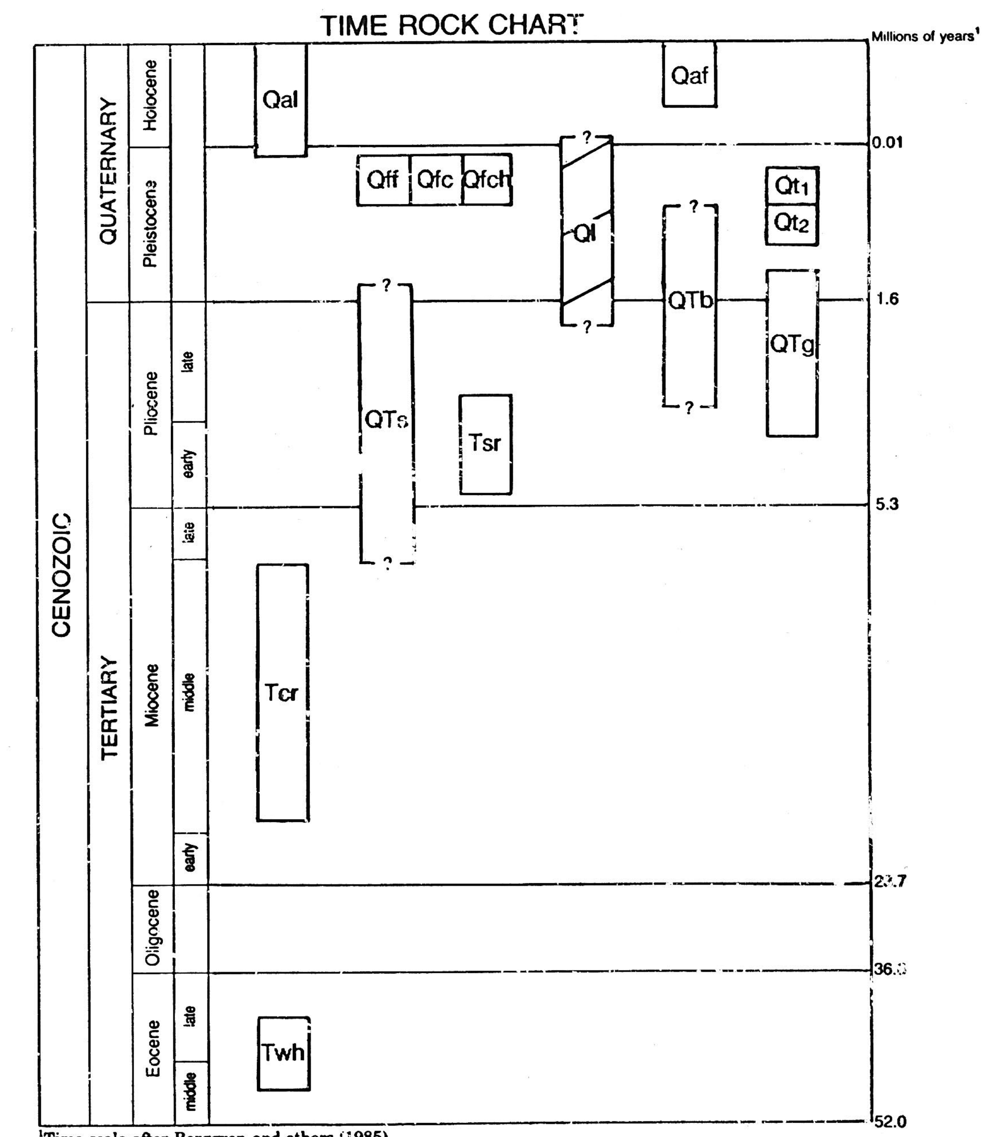


[1]Time scale after Berggren and others (1985)

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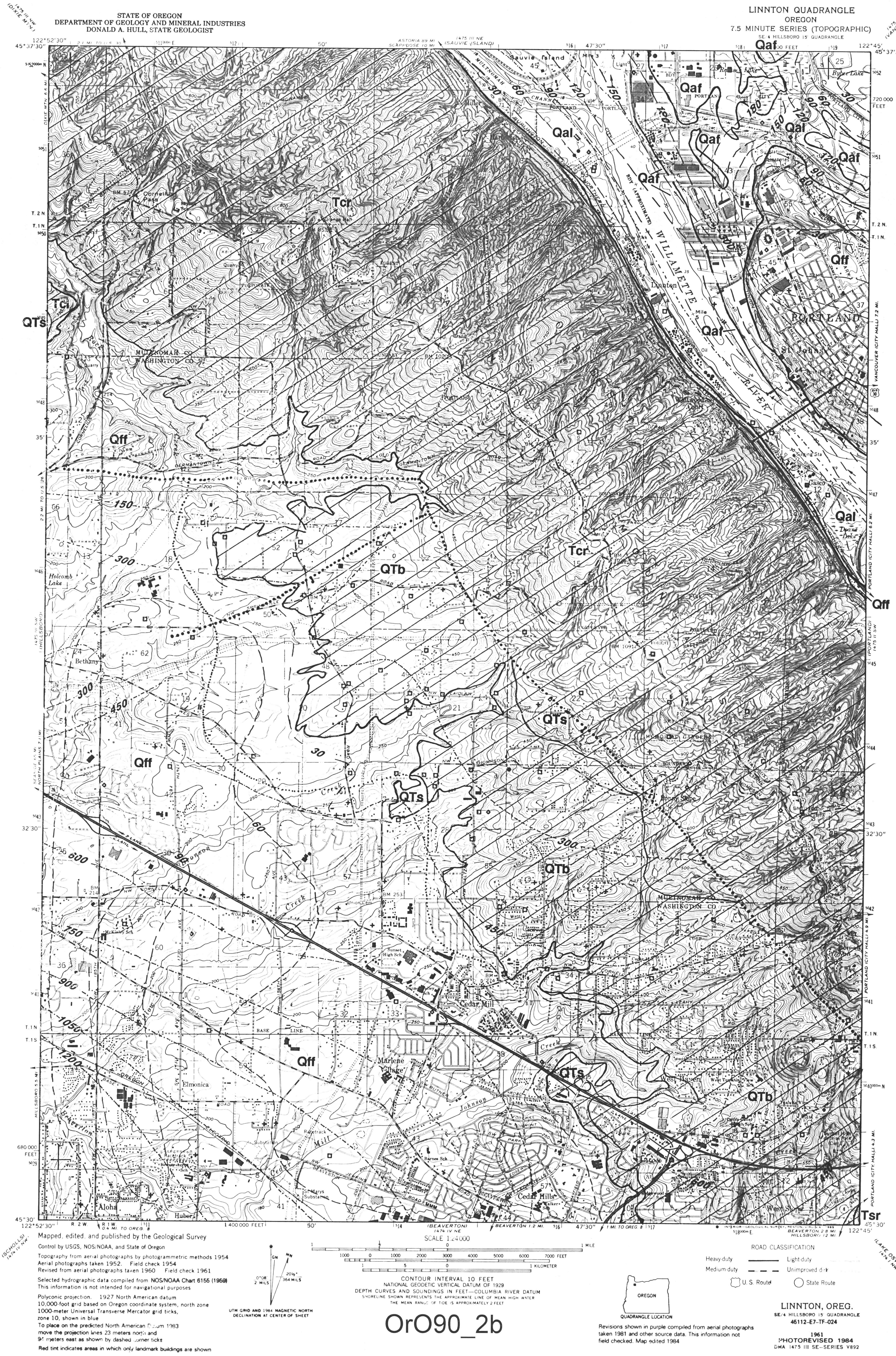


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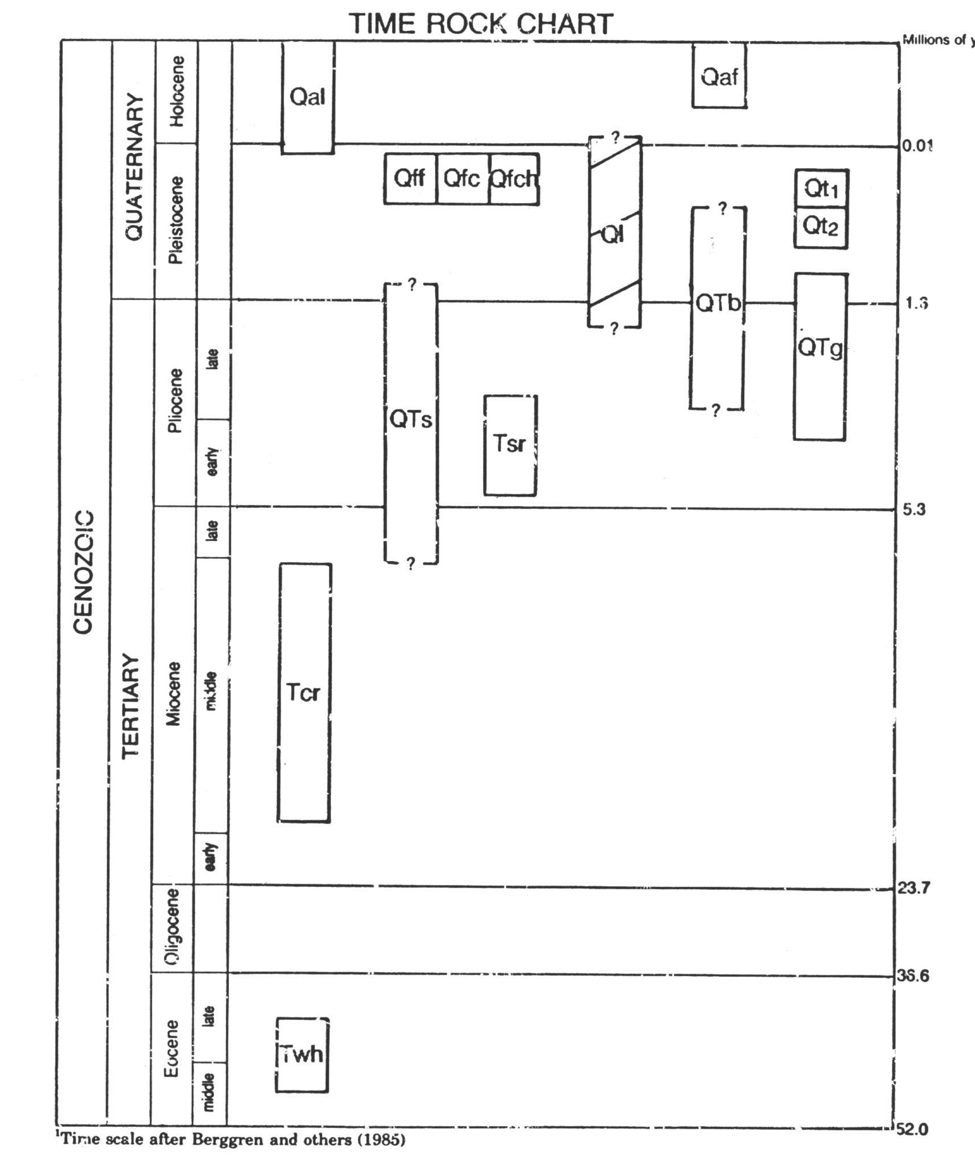


## GEOLOGIC UNITS

Field work completed in 1988-89

| | |
|---|---|
| Qaf | **Artificial fill (Recent)** |
| Qal | **Alluvium (Quaternary)** |
| | **Catastrophic flood deposits (Pleistocene)** |
| Qfch | **Channel facies (Pleistocene)** |
| Qff | **Fine-grained facies (Pleistocene)** |
| Qfc | **Coarse-grained facies (Pleistocene)** |
| $Qt_1$, $Qt_2$ | **Clackamas River terrace surfaces (Pleistocene)** |
| Ql | **Loess (Pleistocene)** |
| QTg | **Troutdale Formation gravels (Pliocene to Pleistocene?)** |
| QTb | **Boring Lavas (Pliocene to Pleistocene)** |
| QTs | **Sandy River Mudstone equivalent (middle Miocene? to Pleistocene)** |
| Tsr | **Sandy River Mudstone (Pliocene)** |
| Tcr | **Columbia River Basalt Group (middle Miocene)** |
| Twh | **Basalt of Waverly Heights and associated undifferentiated sedimentary rocks (Eocene)** |

## MAP SYMBOLS

**Contact**—Approximately located; dotted where buried

**Area overlain by>5 ft of unit Ql**

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**Fault**—inferred from offset of single contact surface; ball and bar on downthrown side. (On Lake Oswego Quad and southwest corner of Gladstone Quad, buried fault inferred from offset of well-defined stratigraphy)

**Thrust fault**—inferred from offset of well-defined stratigraphy; teeth on upper plate

**Anticlinal axis**

*30* **Isopach on units Qff and/or Qal**—30-ft isopach interval

*150* **Depth to basement contour**—150-ft interval

5 **Strike and dip of bed**

**Subsurface data points:**

Hole bottoms in units Qff, Qal, or Ql

Hole bottoms in unit Qfc, Qfch, QTg, QTs, QTb, or Tsr

Hole bottoms in unit Tcr or Twh

**For detailed description of geologic units, see accompanying text**

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

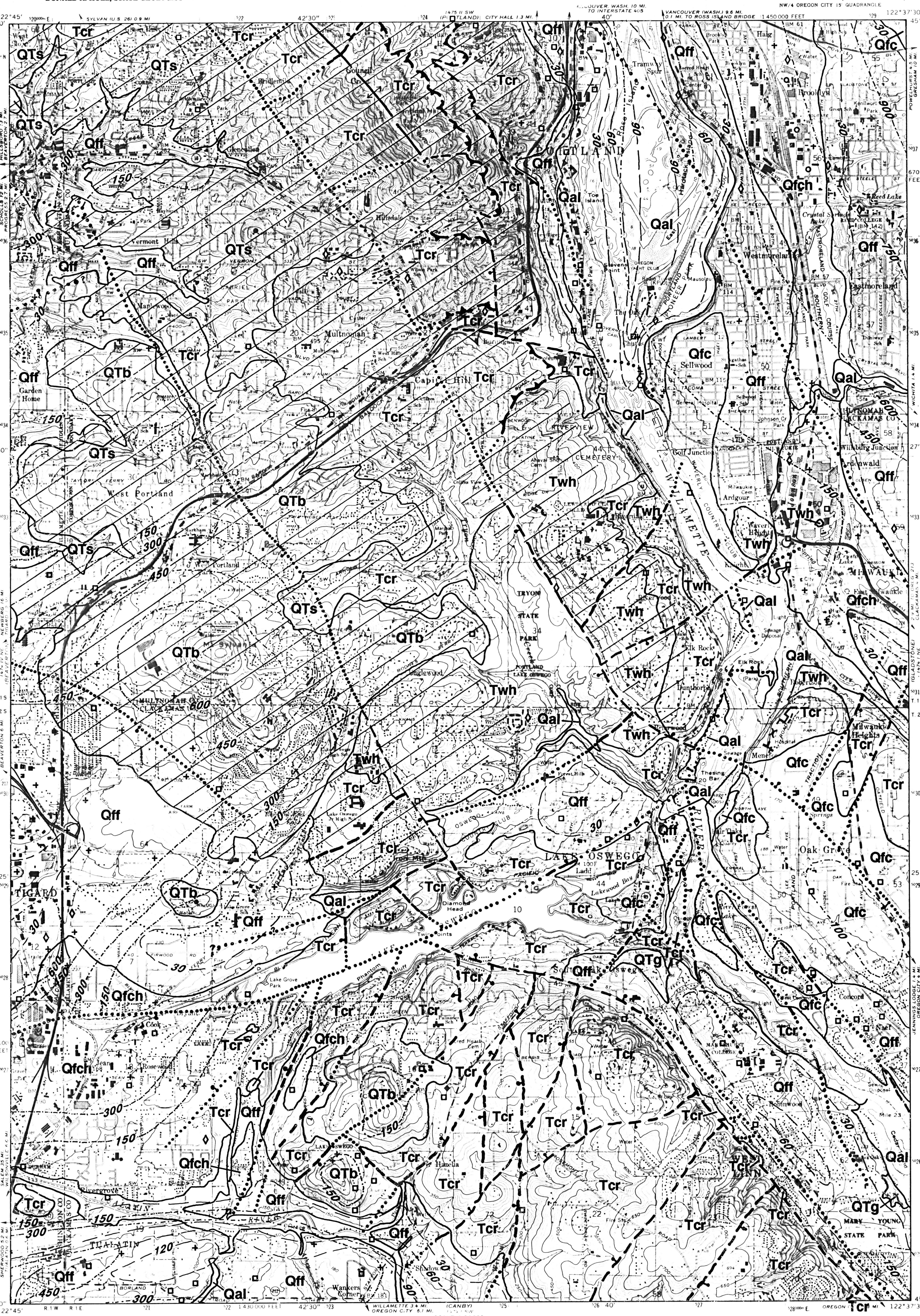
LAKE OSWEGO QUADRANGLE
OREGON
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 OREGON CITY 15' QUADRANGLE

# Open File Report 0 - 90 - 2

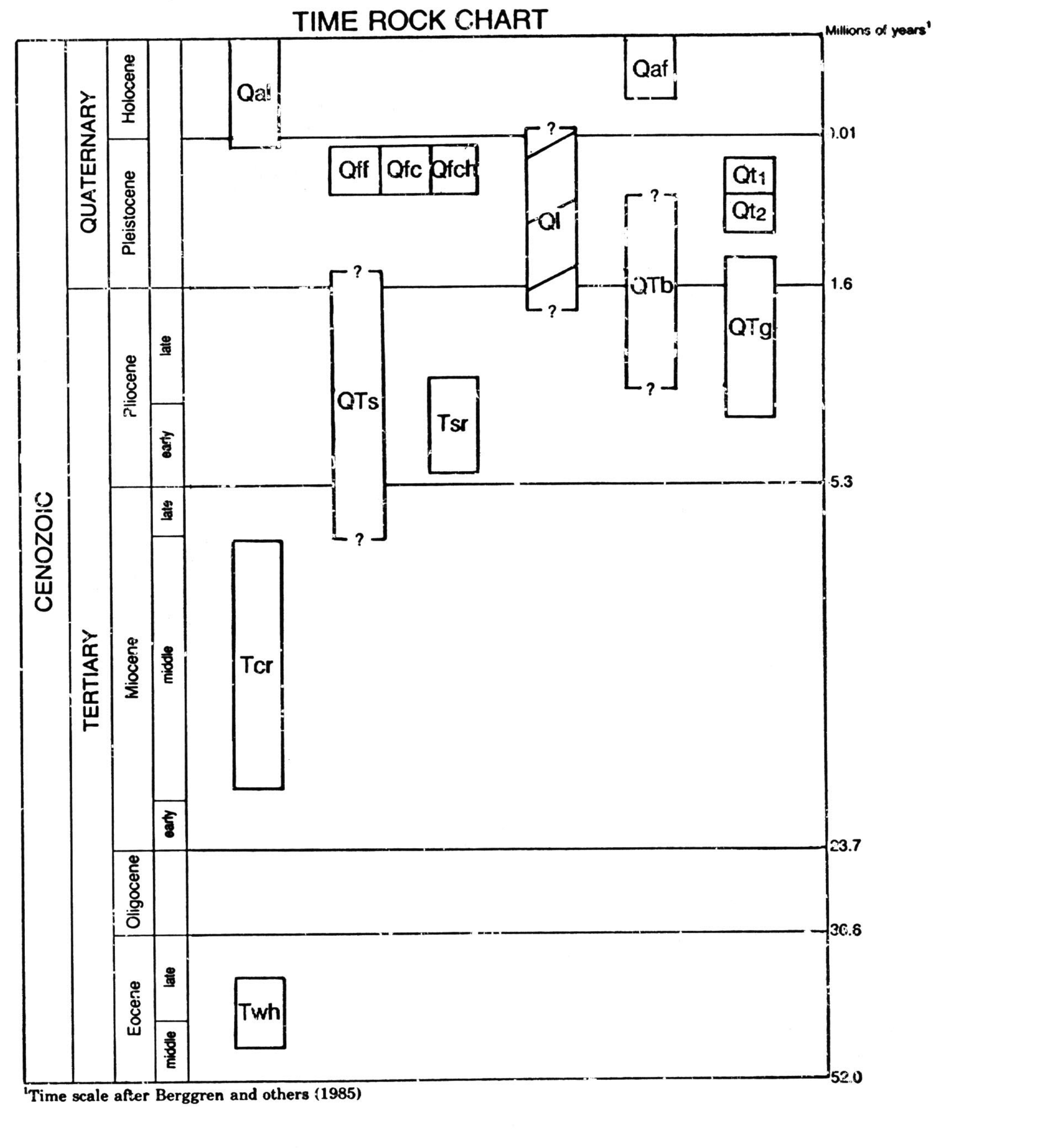
Earthquake hazard geology maps of the Portland metropolitan area, Oregon

By Ian P. Madin

Funded in part by U.S. Geological Survey Cooperative Agreement # 14-08-0001-A0512
as part of the National Earthquake Hazard Reduction Program




TIME ROCK CHART




[1]Time scale after Berggren and others (1985)

## GEOLOGIC UNITS

Field work completed in 1988-89

| | |
|---|---|
| Qaf | Artificial fill (Recent) |
| Qal | Alluvium (Quaternary) |
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| Qfch | Channel facies (Pleistocene) |
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| QTb | Boring Lavas (Pliocene to Pleistocene) |
| QTs | Sandy River Mudstone equivalent (middle Miocene? to Pleistocene) |
| Tsr | Sandy River Mudstone (Pliocene) |
| Tcr | Columbia River Basalt Group (middle Miocene) |
| Twh | Basalt of Waverly Heights and associated undifferentiated sedimentary rocks (Eocene) |

## MAP SYMBOLS

**Contact**--Approximately located; dotted where buried

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**Thrust fault**—inferred from offset of well-defined stratigraphy; teeth on upper plate

**Anticlinal axis**

— *30* — **Isopach on units Qff and/or Qal**—30-ft isopach interval

—· *150* ·— **Depth to basement contour**—150-ft interval

*5* **Strike and dip of bed**

**Subsurface data points:**

◇ Hole bottoms in units Qff, Qal, or Ql

\+ Hole bottoms in unit Qfc, Qfch, QTg, QTs, QTb, or Tsr

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**For detailed description of geologic units, see accompanying text**

Mapped, edited, and published by the Geological Survey
Control by USGS, NOS/NOAA, USCE, and State of Oregon

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1952. Field checked 1954
Revised from aerial photographs taken 1960. Field checked 1961

Selected hydrographic data compiled from NOS/NOAA
Charts 6155 (1959) and 6171 (1958)
This information is not intended for navigational purposes
Polyconic projection. 1927 North American datum
10,000-foot grid based on Oregon coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks,
zone 10, shown in blue
To place on the predicted North American Datum 1983
move the projection lines 23 meters north and
94 meters east
Red tint indicates areas in which only landmark buildings are shown
There may be private inholdings within the boundaries of
the National or State reservations shown on this map

UTM GRID AND 1984 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—COLUMBIA RIVER DATUM
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 2 FEET

OrO90_2g

QUADRANGLE LOCATION

Revisions shown in purple compiled from aerial photographs
taken 1981 and other sources. This information not field checked
Map edited 1984

Purple tint indicates extension of urban areas

ROAD CLASSIFICATION

Heavy-duty | Light-duty
Medium-duty | Unimproved dirt
Interstate Route | U. S. Route | State Route

LAKE OSWEGO, OREG.
NW/4 OREGON CITY 15' QUADRANGLE
45122-D6-TF-024

1961
PHOTOREVISED 1984
DMA 1474 I NW—SERIES V892

# Open File Report 0 - 90 - 2

Earthquake hazard geology maps of the Portland metropolitan area, Oregon

By Ian P. Madin

Funded in part by U.S. Geological Survey Cooperative Agreement # 14-08-0001-A0512
as part of the National Earthquake Hazard Reduction Program

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

MOUNT TABOR QUADRANGLE
OREGON—WASHINGTON
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 PORTLAND 15' QUADRANGLE


Mapped, edited, and published by the Geological Survey

Control by USGS, NOS/NOAA, and State of Oregon

Topography from aerial photographs by photogrammetric methods and by planetable surveys. Culture and drainage in part by USC&GS Aerial photographs taken 1951 and 1952. Field checked 1954 Revised from aerial photographs taken 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grids based on Oregon coordinate system, north zone and Washington coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue

Selected hydrographic data compiled from USC&GS Chart 6156 (1959)
This information is not intended for navigational purposes

Red tint indicates areas in which only landmark buildings are shown

Fine red dashed lines indicate selected fence lines

Purple tint indicates extension of urban areas

UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—COLUMBIA RIVER DATUM
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 2 FEET

OrO90_2d

Revisions shown in purple compiled from aerial photographs taken 1970 and 1975. This information not field checked
Map edited 1978

ROAD CLASSIFICATION

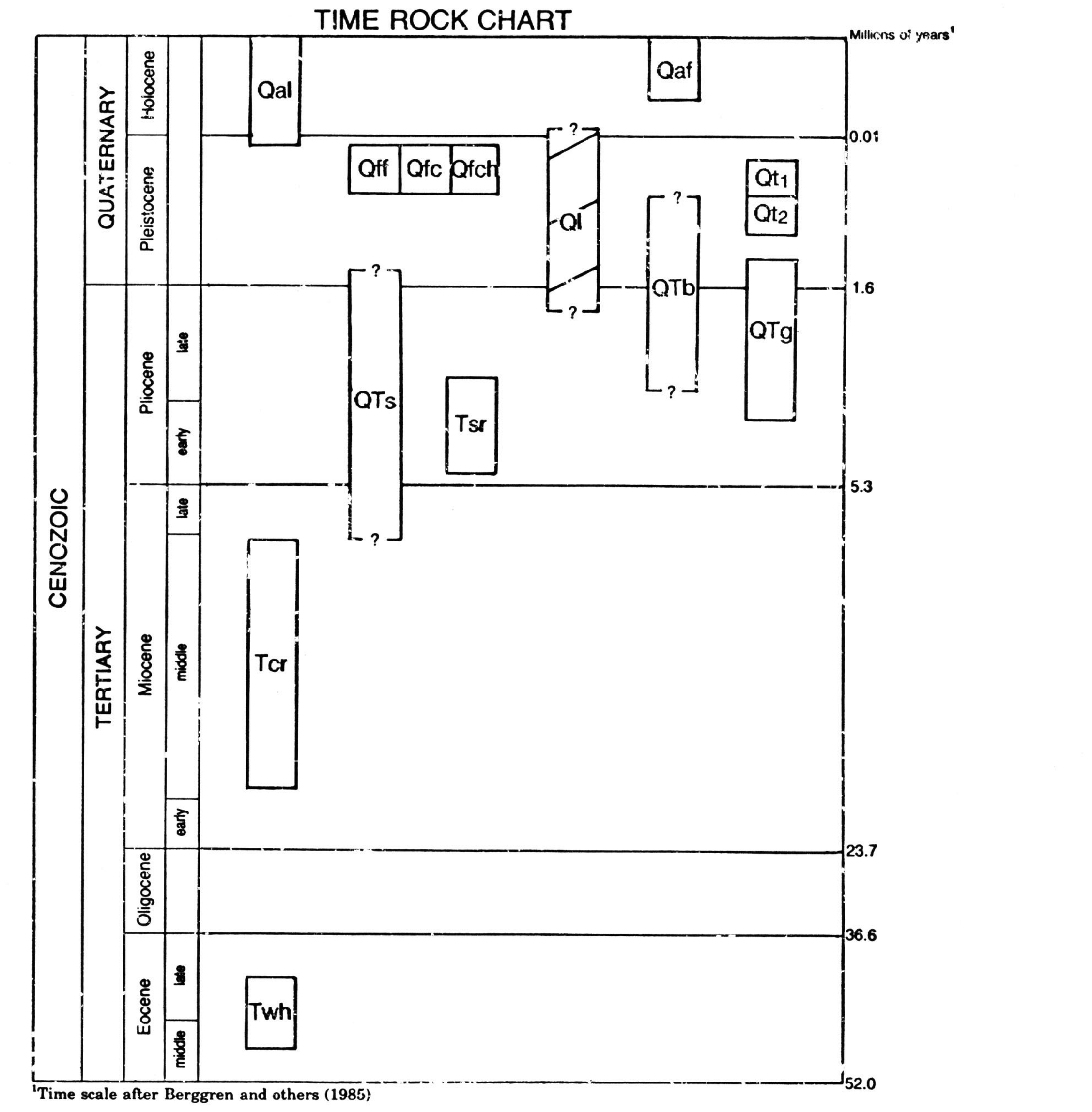
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
Interstate Route — U. S. Route — State Route

QUADRANGLE LOCATION

MOUNT TABOR, OREG.—WASH.
SE/4 PORTLAND 15' QUADRANGLE
N4530—W12230/7.5

1961
PHOTOREVISED 1970 AND 1978
AMS 1475 II SE—SERIES V892

## TIME ROCK CHART




## GEOLOGIC UNITS

Field work completed in 1988-89

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## MAP SYMBOLS

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Anticlinal axis

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Subsurface data points:

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STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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Funded in part by U.S. Geological Survey Cooperative Agreement # 14-08-0001-A0512
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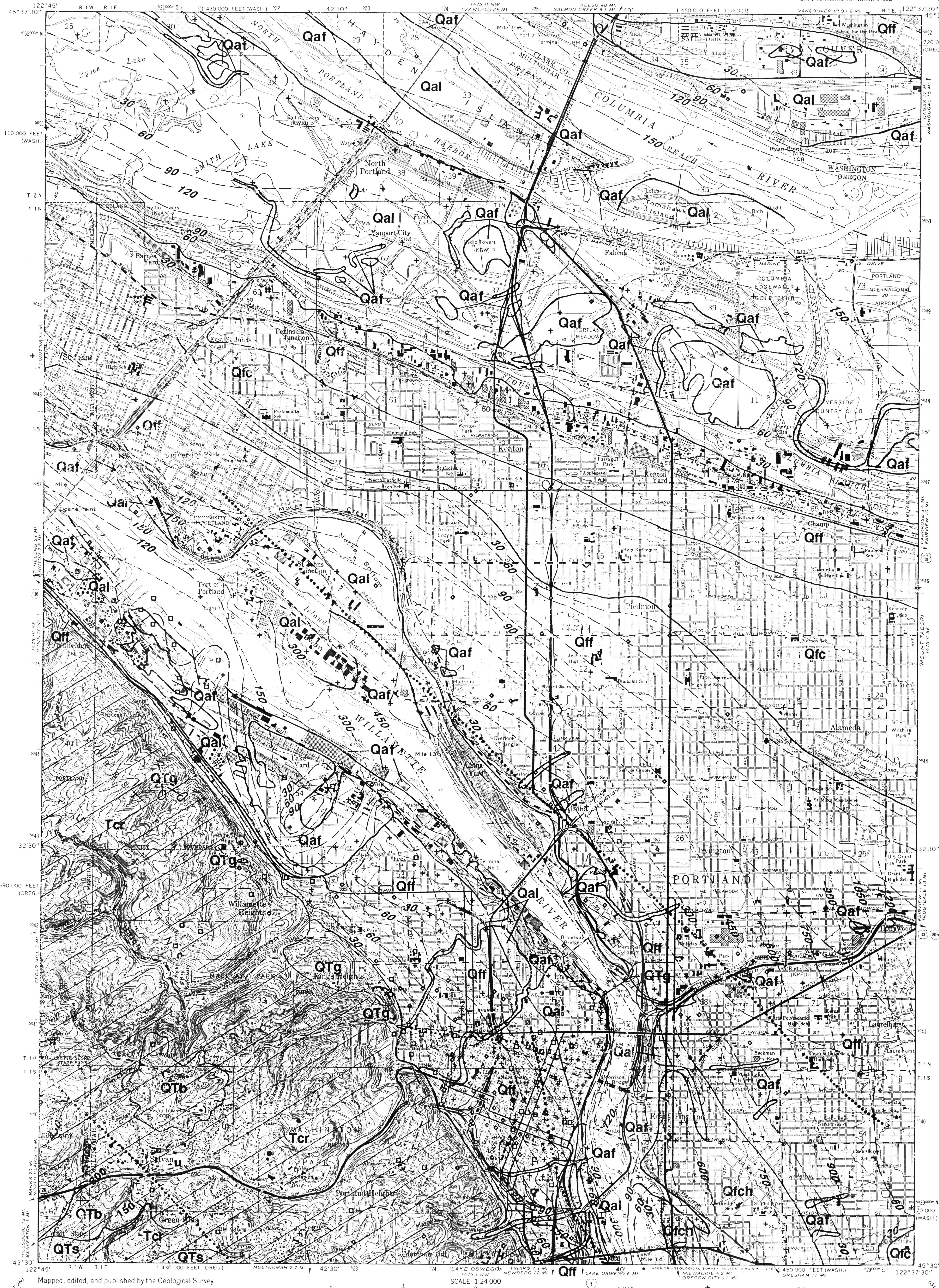


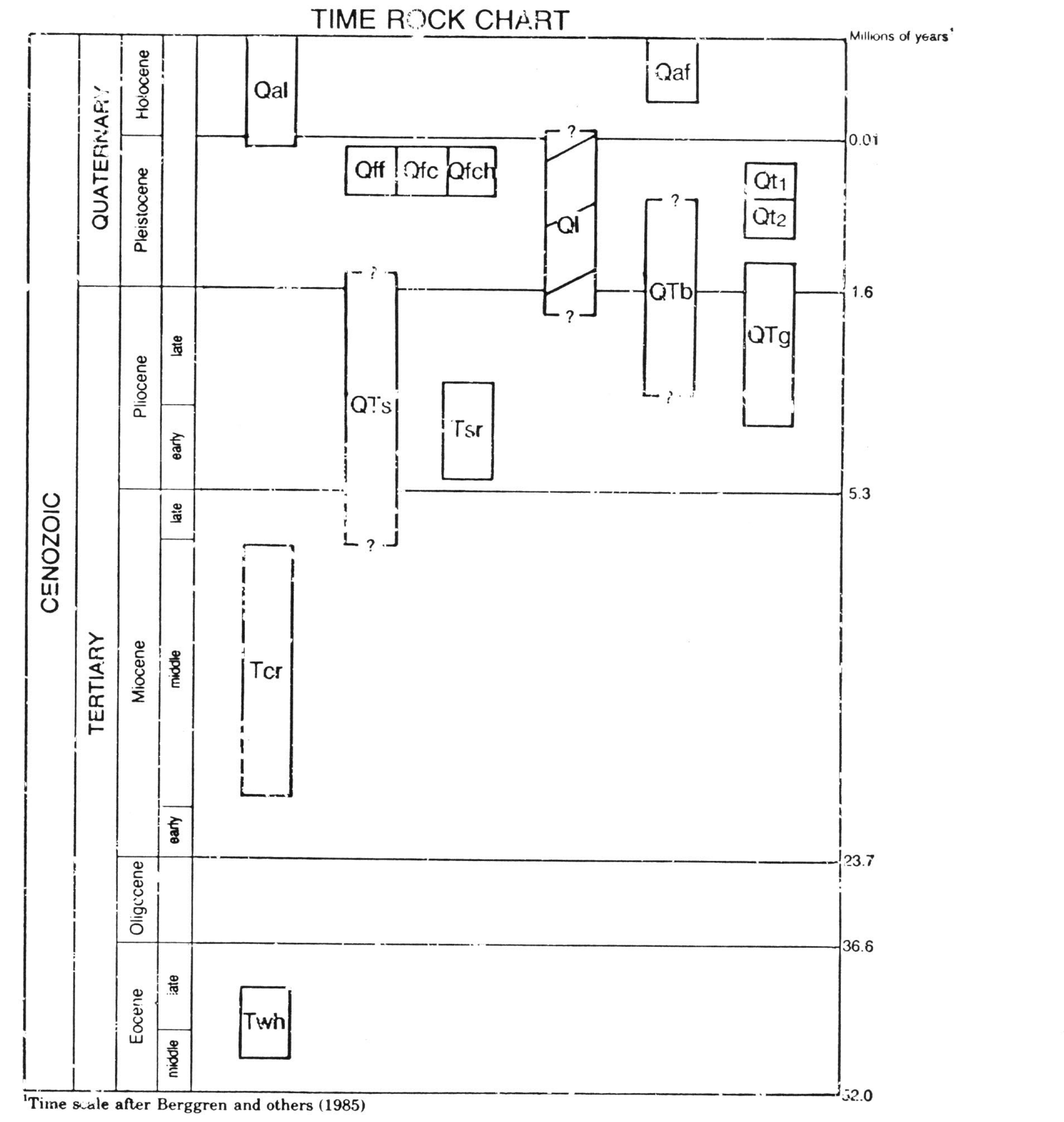


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Red tint indicates areas in which only landmark buildings are shown

Dashed land lines indicate approximate locations

UTM GRID AND 1977 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

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DEPTH CURVES AND SOUNDINGS IN FEET—COLUMBIA RIVER DATUM
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ROAD CLASSIFICATION
Heavy duty — Light duty
Medium duty — Unimproved dirt
Interstate Route — U.S. Route — State Route

OrO90_2c

Revisions shown in purple compiled from aerial photographs taken 1970 and 1975. This information not field checked
Map edited 1977

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SW/4 PORTLAND 15' QUADRANGLE
N4530—W12237.5/7.5

1961
PHOTOREVISED 1970 AND 1977
AMS 1475 II SW—SERIES V892

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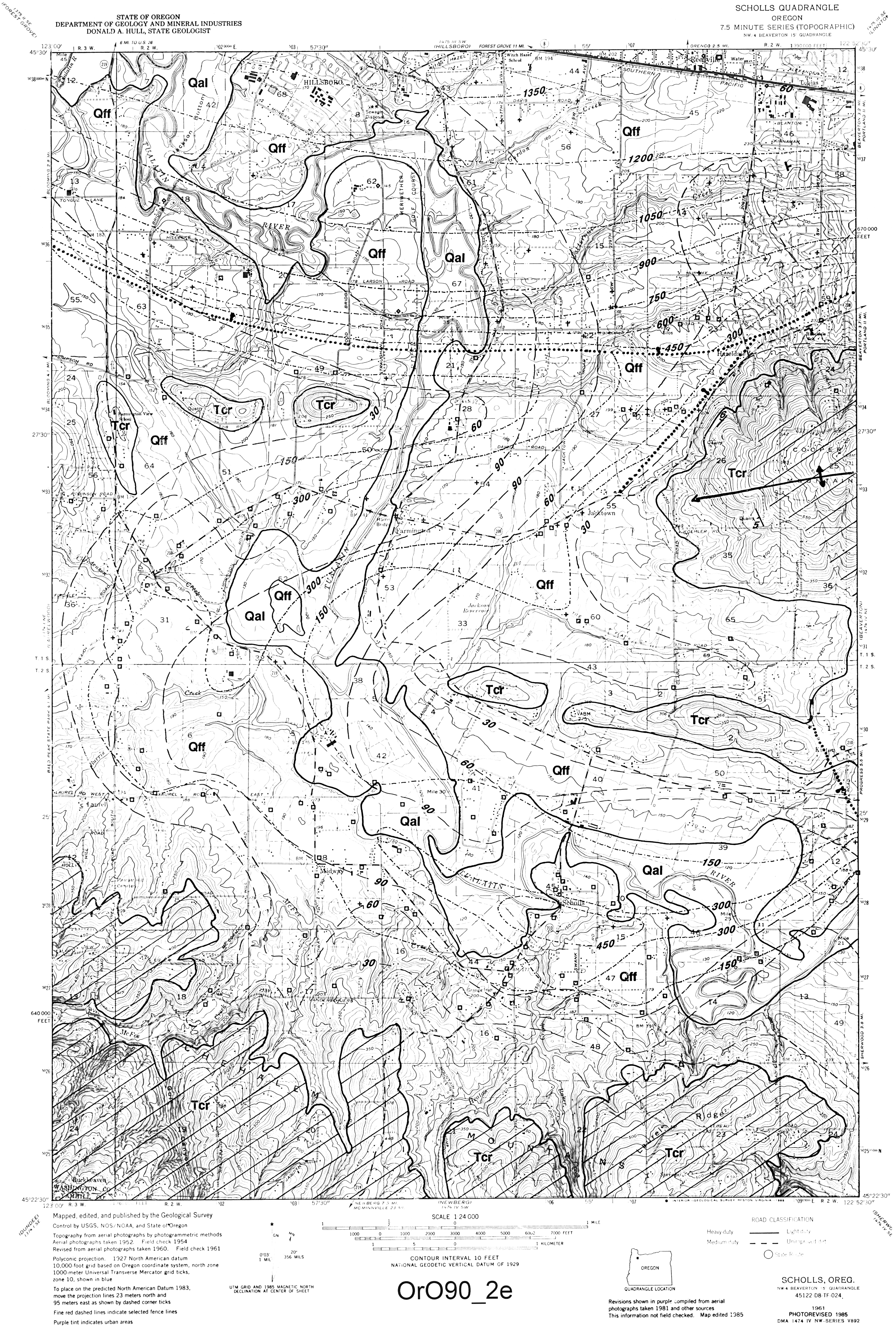
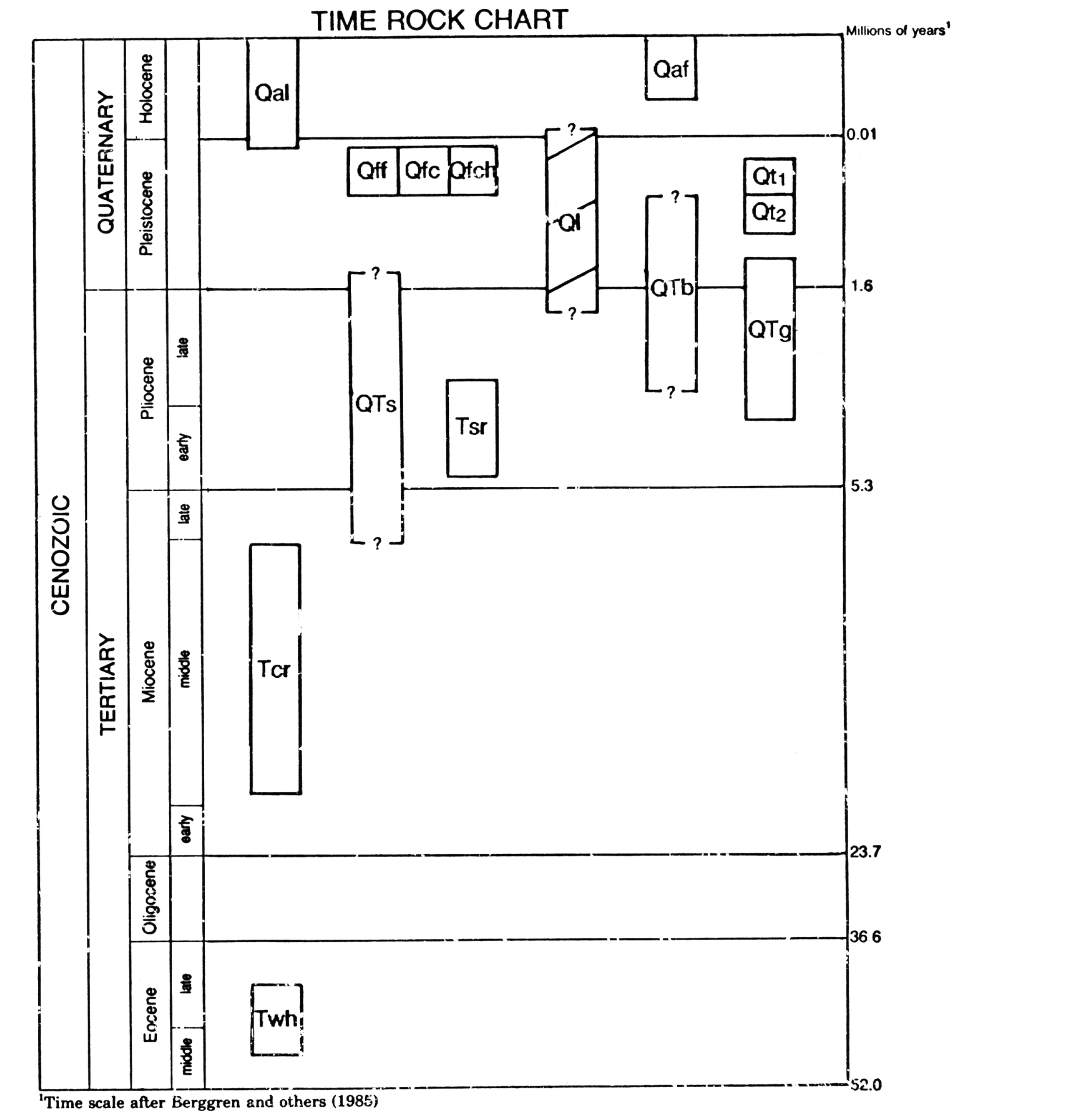



## TIME ROCK CHART

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