U.S. DEPARTMENT OF THE INTERIOR
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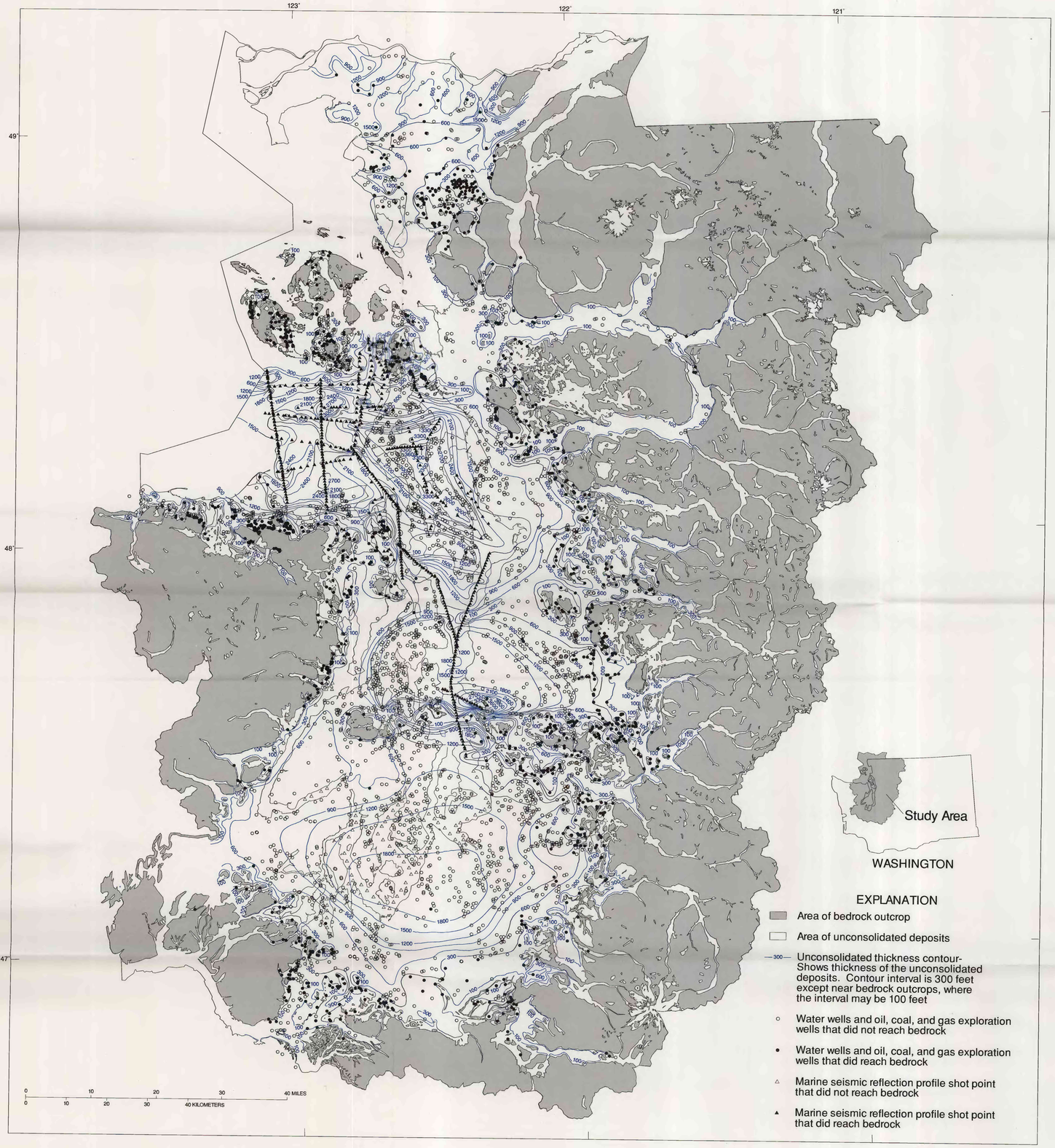
WATER-RESOURCES INVESTIGATIONS REPORT 94-4133
Deposits in the Puget Sound Lowland--PLATE 1
M.A. Jones, 1996, Thickness of unconsolidated deposits in the Puget Sound Lowland, Washington and British Columbia



ABSTRACT

The Puget-Willamette Lowland is located in western Washington, western Oregon, and a small part of southwestern British Columbia, Canada. The Puget-Willamette Lowland study area is composed of two distinct subareas, the Puget Sound Lowland and the Willamette Lowland. This report presents the results of mapping the thickness of the unconsolidated deposits in the Puget Sound Lowland.

The thickness of the unconsolidated deposits ranges from a discontinuous veneer in areas of bedrock outcrop to more than 3,600 feet. Available information shows that the unconsolidated deposits are thickest in the Fraser-Whatcom, Everett, Seattle, and Tacoma Basins. The mapped thickness of the unconsolidated deposits in the Tacoma Basin is probably underestimated because of the scarcity of wells penetrating the full thickness of the unconsolidated deposits and the lack of sufficient marine-seismic data.

INTRODUCTION

This report is a part of a study of the ground-water systems in the Puget-Willamette Lowland, conducted under the U.S. Geological Survey's Regional Aquifer System Analysis (RASA) program. The goal of the program was to develop a comprehensive assessment of the nation's ground-water resources. Objectives, approach, and plan of study for the RASA program were presented by J.J. Vaccaro (1992). The Puget-Willamette Lowland contains two regional aquifer systems: the Puget Sound aquifer system, located in the Puget Sound Lowland of western Washington and British Columbia, Canada, and the Willamette Lowland aquifer system, located in the Willamette Lowland of western Oregon and southwestern Washington. The purpose of this report is to present the results of mapping the thickness of the unconsolidated deposits in the Puget Sound Lowland.

The boundaries of the Puget Sound Lowland study area are defined by the Fraser River in British Columbia, Canada, and the Canada-Washington boundary on the north, by the drainage divide of the Cascade Range on the east, by both the drainage divide of the Olympic Mountains and the Canada-Washington boundary on the west, and by a series of low hills that lie south of the town of Tenino, Wash., on the south.

The Puget Sound Lowland is an elongated structural basin that extends over 200 mi in a north-south direction and varies from 60 to 120 mi in its east-west direction. The present shape and form of the lowland has been influenced in part by the tectonic events that have occurred throughout geologic time, but primarily by the tectonic and glacial events that occurred during the Tertiary and Quaternary periods.

The complex geologic structures that exist are initially a result of early-middle Tertiary tectonic activity caused by the subduction of the Juan de Fuca plate below the North American plate (McCrumb and others, 1989; Thorson, 1989; Gower and others, 1985). The area is seismically active, and earthquakes of low and moderate magnitude occur frequently (Crosson, 1972). Active faults have been recognized along the margin of the unconsolidated deposits, where the deposits are relatively thin
(Carson, 1973; Wilson and others, 1979). In the central part of the lowland, geophysical data imply several deeply buried fault structures that separate the lowland into several basins (Rogers, 1970; Gower, 1978; Gower and others, 1985; Cheney, 1987) (fig. 1). The origin of these structures appears to be a result of either faulting or folding that may have begun during the Tertiary but many of these structures continued into the Pleistocene (Johnson, 1994).

The unconsolidated Quaternary deposits generally lie within the central part of the lowland, but also are found in parts of the drainage areas of the Cascade Range and the Olympic Mountains. The areal extent of the unconsolidated deposits is about 9,750 mi^2. These deposits include continental and alpine glacial and interglacial deposits, lacustrine and fluvial deposits, and mudflow deposits.

The consolidated rocks in the Puget Sound Lowland form the lateral and vertical boundaries of the unconsolidated deposits. The rocks are of Tertiary and older ages. The Tertiary rocks consist largely of marine and non-marine sedimentary and volcanic rocks. Outcrops of the Tertiary rocks are generally located in the southern half of the Puget Sound Lowland and are assumed to form the base of the unconsolidated deposits in the southern half of the lowland. The older deposits are composed of an assortment of rocks that include chert, limestone, greenstone, gabbro, diorite, phyllite and schist. Outcrops of these older rocks are generally located in the northern half of the Puget Sound Lowland and are assumed to form the base of the unconsolidated deposits in the northern half of the study area.

DATA SOURCES AND LIMITATIONS

The thickness of the unconsolidated deposits map was compiled from well records and information from several existing reports, including unconsolidated thickness maps by Hall and Othberg (1974), Yount and others (1985), Yount (in press), and Buchanan-Banks and Collins (1994); gravity maps by Stuart (1965), Bonini and others (1974), and Danes and others (1965); aeromagnetic maps by the U.S. Geological Survey (1977); and tectonic and seismic maps by Gower (1978 and 1980), Gower and others (1985), Cheney (1987), and Gordy (1988).

In Washington and Canada combined, records from 3,909 water, oil, coal, and gas wells and 701 shot sites from previously reported marine-seismic reflection profiles were selected according to the following general criteria. Wells were selected that penetrated bedrock; if such wells were lacking in an area, then the deepest well completed in the unconsolidated deposits was generally selected, in order to provide a minimum unconsolidated thickness. Wells were also selected on the basis of their location and the density of other wells in the surrounding area, and on the availability of geophysical logs, geological logs, or well drillers' logs. Data from the marine-seismic reflection profiles were selected on the basis of their location in the Puget Sound Lowland. Unconsolidated thicknesses from the marine-seismic profiles are based on the change in seismic velocity between consolidated and unconsolidated deposits.

Because of the small scale of the plate, the lack of data in some areas, the inferred variable relief on the buried bedrock surface, and the lack of wells that penetrate bedrock, a contour interval of 300 ft was used, except near the bedrock outcrops where a 100-ft contour was selectively added. Outlines of the exposed bedrock were used as the zero-thickness contour and other contours have been interpolated and drawn in accordance with the available data.

This map is only an approximation, but should provide a generalized picture of the thickness of the unconsolidated deposits in the Puget Sound Lowland. This map may be useful for predicting ground response resulting from earthquakes (Hayes, 1980), for interpreting processes of sedimentation in basins (Potter and Pettijohn, 1977), and for locating potential aquifers.

THICKNESS OF UNCONSOLIDATED DEPOSITS

The thickness of unconsolidated deposits ranges from a discontinuous veneer in areas of bedrock outcrop to thicknesses of more than 3,600 ft in the central part of the lowland. The distribution of thickness for the Puget Sound Lowland is shown in feet below the land surface or below the sediment-seawater interface. The greatest thicknesses of unconsolidated deposits are in the Fraser-Whatcom, Everett, Seattle, and Tacoma Basins (fig. 1).

Unconsolidated deposits as much as 1,500 ft thick were contoured in the Fraser-Whatcom Basin. The largest thickness recorded is about 1,670 ft, based on a well located near Abbotsford, British Columbia. Data for contouring the thickness of deposits in the Fraser-Whatcom Basin were predominantly from older coal exploration records, available geophysical, aeromagnetic, and gravity information, and some drillers' well logs (Gordy, 1988; Halstead, 1966, 1986). Information on the thickness of the unconsolidated deposits offshore was lacking for Canada and the northern part of the Puget Sound; thus, thicknesses in these areas were not contoured.

The Everett Basin lies between the northern and southern Whidbey Island Faults (fig. 1). Unconsolidated deposits as much as 3,600 ft thick were contoured in this basin. The largest thickness recorded was more than 3,660 ft, obtained from a shot site located in the Saratoga Passage between Whidbey and Camano Islands (Yount, in press). Most of the data for this basin were from marine-seismic profiles (Yount, in press), drillers' well logs, and a few oil- and gas-exploration wells.

The Seattle Basin lies between the Mountlake Terrace Anticline and the Seattle Fault Zone (fig. 1). Unconsolidated deposits as much as 3,600 ft thick were contoured in this basin. The largest unconsolidated thickness recorded is about 3,730 ft, obtained from a shot site located near Seattle, Wash. (Yount and others, 1985). Most of the available data for this basin were from marine-seismic profiles (Yount and others, 1985), from drillers' well logs, and oil- and gas-exploration wells.

The Tacoma Basin lies to the south of the Seattle Fault Zone. Unconsolidated deposits as much as 1,800 ft thick were contoured in this basin. The largest thickness recorded is about 1,980 ft, based on information from a well located near Tacoma, Wash. Most of the available data for this basin were from driller's well logs and some oil- and gas-exploration wells (Buchanan-Banks and Collins, 1994). The mapped thickness of unconsolidated deposits in this basin is probably underestimated because of the lack both of logs for wells that penetrate bedrock and of available marine-seismic data.

Little information is available on the thickness of the unconsolidated deposits in the glacial valleys of the Cascade Range and the Olympic Mountains. Although some of the unconsolidated deposits in these valleys have been partly contoured, the thickness of the deposits is mostly unknown. On the basis of the present knowledge of glacial and geologic process, the thickness of the unconsolidated deposits in these valleys could be considerable. However, there are not enough data available at present to prove or disprove this theory.

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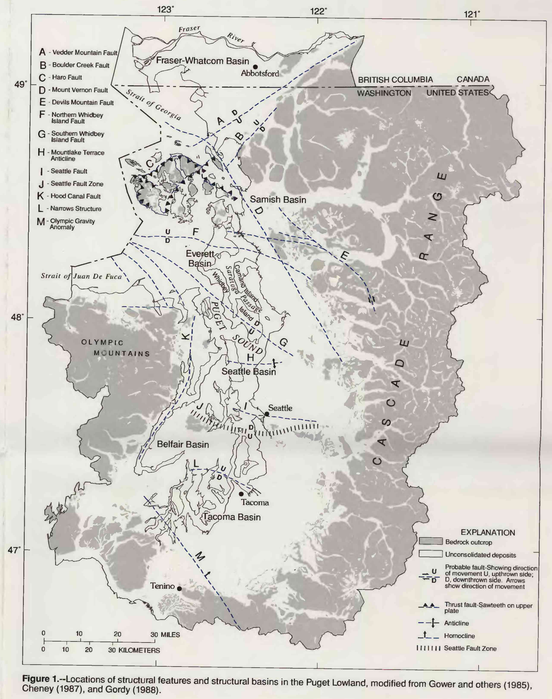

Figure 1.--Locations of structural features and structural basins in the Puget Lowland, modified from Gower and others (1985), Cheney (1987), and Gordy (1988).

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