Field and Laboratory Data from an Earthquake History Study of the Toe Jam Hill Fault, Bainbridge Island, Washington

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Open-File Report 02-60

Introduction and Data Tables 1 and 2
(8.5x11-inch paper format)

February 2002

U.S. Department of the Interior
U.S. Geological Survey

INTRODUCTION

The Seattle fault zone, which extends at least 70 km east-west through the central Puget Lowland and metropolitan Seattle (Figure 1), is one of a number of poorly understood fault zones that pose potential earthquake hazards to life and property in the lowland (Gower and others, 1985; Johnson and others, 1996,1999; Sherrod and others, 2000; Bourgeois and Johnson, 2001; Brocher and others, 2001). The northernmost fault in the Seattle fault zone produced an earthquake of at least magnitude 7 between AD 900 and 930 (Bucknam and others, 1992; Atwater and Moore, 1992; Atwater, 1999), but whether or not other large Holocene earthquakes have occurred on faults in the zone—and, if so, their frequency and periodicity—are the subject of debate (Thorson, 1996; Sherrod and others, 2000). New Airborne Laser Scanner Mapping (ALSM) imagery has led to the discovery of the first Holocene fault scarp in the Seattle fault zone, on Bainbridge Island 15 km west of downtown Seattle (Bucknam and others, 1999; Harding and Berghoff, 2000). This discovery makes standard methods of trenching the active surface traces of faults (for example, McCalpin, 1998) practical for the first time in the Puget Lowland. Study of stratigraphic and structural relations in trenches across fault scarps is the most direct way of deciphering the history of large earthquakes on faults. Such histories are critical in the assessment of regional earthquake hazards.

This map presents primary field and laboratory data and interpretations of stratigraphic unit genesis and structural relations that are being used to develop a latest Pleistocene and Holocene history of large earthquakes on the Toe Jam Hill fault in the Seattle fault zone. The fault extends east-west for about 2.6 km across the southern tip of Bainbridge Island (Figure 2, Plate 1). Two trenches excavated across the scarp of the Toe Jam Hill fault were studied in 1998 (Bear’s Lair and Saddle, Plate 2), and in 1999 we completed the study of three more. Types of data presented include: logs (maps of vertical or sloping walls) of the five trenches; lithologic, grain-size distribution, sedimentary and tectonic structures, and radiocarbon data for trench stratigraphic units; topographic profiles measured across the fault scarp at each trench site; and descriptions of soil profiles in and near each trench. The map does not show how surface faulting and folding events identified in each trench may correlate among trenches or attempt to use the primary data presented to develop an earthquake history for the Toe Jam Hill fault. These latter objectives, and how they impact earthquake hazard assessment in the Puget Lowland, are the subject of a future report. Preliminary conclusions about the earthquake history of the Toe Jam Hill fault are reported by Nelson and others (2000).

The map consists of two plates and two text files of data tables. This is the first text file, which includes a brief introduction. Each of the plates and files is available as a separate file (four total) in portable document format (PDF). Plate 1 includes a trench site location figure (Figure 2) derived from ALSM imagery data and the log of the west wall of the Crane Lake trench. Also included on Plate 1 are topographic profiles measured in the field across the scarp of the Toe Jam Hill fault at four of the trench sites and one other location (methods of Machette, 1989). For comparison, two similar profiles were measured directly from the upper edge of two of the completed trench logs. Plate 2 contains the logs of the west walls of the Blacktail and Bear’s Lair trenches and the east walls of the Mossy Lane and Saddle trenches. Plate 2 also includes an explanation of the colors used to show inferred genesis of stratigraphic units on the trench logs. Methods used to map the trench walls are similar to those described by McCalpin (1998, p. 56-75). The upper 1-3 meters of the west wall of the Crane Lake trench was sloped 5-40º from vertical for safety; on the trench log (Plate 1) stratigraphy has been projected as much as 2 m eastward into the vertical plane of the lower part of the trench. Adjacent to each log is a summary explanation of stratigraphic units and symbols used on the log and notes about important stratigraphic relations or interpretations of units. Note that neither the colors nor the numbers used to label stratigraphic units imply direct chronologic correlation of units from trench to trench. We do, however, infer a similar genesis for units of the same color on different logs. Units on logs follow geologic convention in being numbered from oldest to youngest; unit explanations are presented from left to right and top to bottom to increase readability on plates with limited space.

The two text files of data tables include additional field and laboratory data for samples from stratigraphic units in the trenches and soil profiles described in and near the trenches. Except for Table 4, tables are numbered with letters that identify the trench (CL – Crane Lake trench, BT – Blacktail trench, BL – Bear's Lair trench, ML – Mossy Lane trench, S – Saddle trench) and a number. Radiocarbon data are presented in tables numbered with a "1" (for example, CL1, ML1). Tables numbered with a "2" list field and laboratory properties of soil profiles. The large-format (11x17-inch paper) tables numbered with a "3" include detailed lithologic and related information about stratigraphic units not shown on the trench logs. Although we worked to standardize the terms used and the degree of detail described for particular properties in the unit descriptions (tables numbered with a "3"), some inconsistencies remain because the trenches were described over limited periods of time by investigators with different backgrounds and interests. Table 4 includes brief descriptions and interpretations of fossils (pollen, diatoms, vascular plant fragments) found in samples from the trenches that help in determining the genesis and age of units. Most of the 48 sieved samples that were barren of fossils or yielded only charcoal fragments are not listed on Table 4 or marked on the trench logs because such samples provide little information about paleoenvironments. Sieved samples whose charcoal was successfully ^{14}C-dated are listed on tables numbered "1" and marked by triangles on the trench logs. In general, tables do not repeat information that is shown on the trench logs or in other tables. References to methods of description and analysis are included in the notes at the bottom of tables. These and other cited references are listed below.

This file (Introduction and Data Tables 1 and 2) should be printed on 8.5x11-inch paper. The other text file (Data Tables 3 and 4) includes the large-format tables that need to be printed on 11x17-inch paper.

ACKNOWLEDGEMENTS

This study was supported by the Earthquake Hazards Reduction Program of the U.S. Geological Survey. Land access and logistical support provided by Port Blakely Tree Farms, L.P., through the tireless efforts of Scott Sheldon, made this study possible. Pat ("Pat on a Cat") Cearley of Burley, Washington, expertly excavated the trenches and, along with Jon Dueker (Woodinville, Washington), guided us in site restoration. Derek Booth and Kathy Troost (Univ. of Washington) took an early interest in our work and helped interpret glacial sediments. Unsung trench loggers include John Cox, Charles Narwold, and Mark Molinari (Dames and Moore, Seattle). Gerry Elfendahl first pointed out the Toe Jam Hill fault scarp on ALSM imagery provided by Kitsap County Public Utilities District No. 1.

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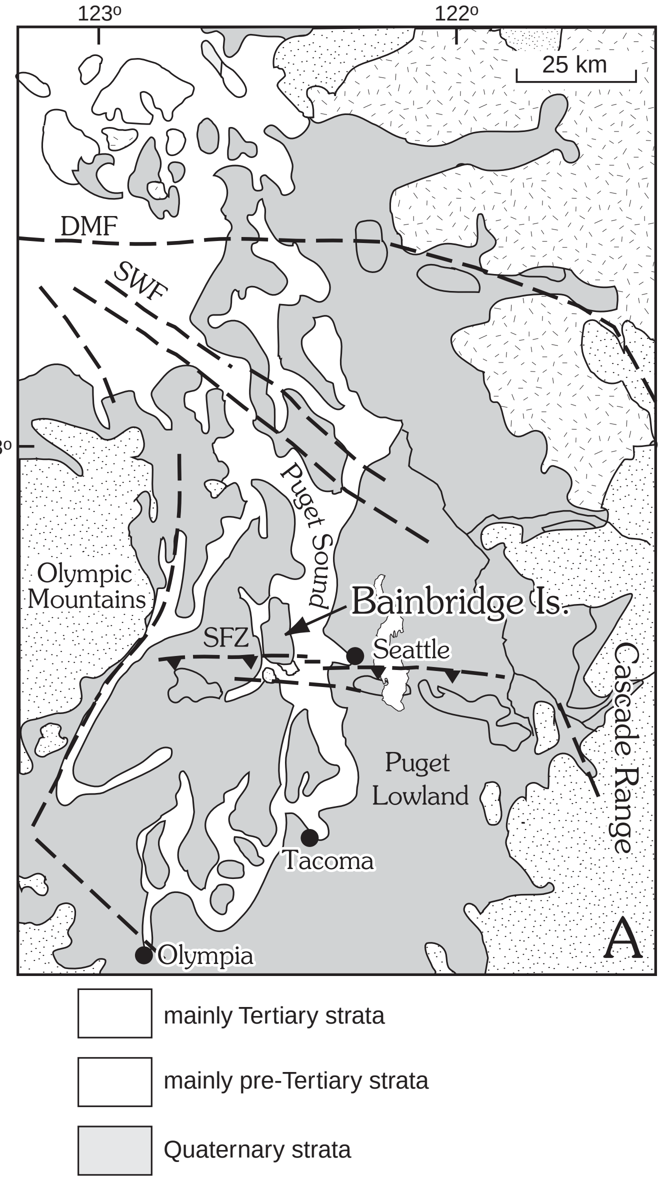

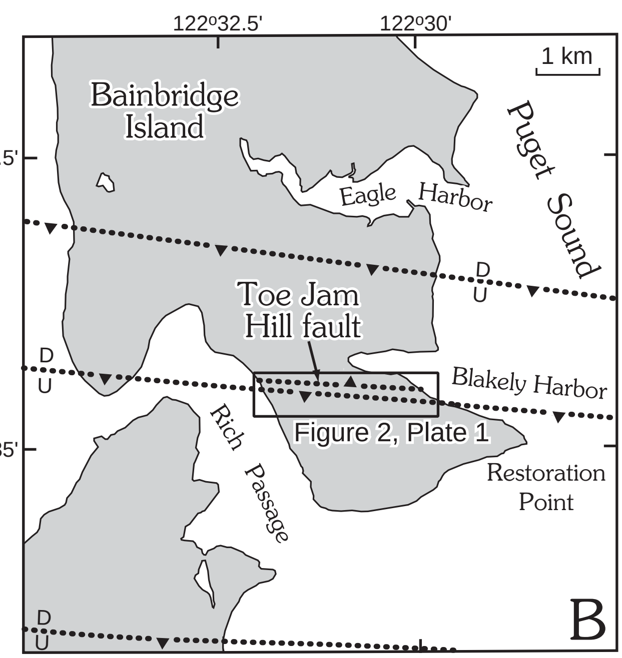

Figure 1. A, Generalized geologic map of the Puget Lowland region showing location of Bainbridge Island and selected regional crustal faults (dashed lines; after Bourgeois and Johnson, 2001). Abbreviations: DMF-Devils Mountain fault; SFZ-Seattle fault zone; SWF-southern Whidbey Island fault. B, Map showing the location of the Toe Jam Hill fault on southern Bainbridge Island and the area of Figure 2 on Plate 1. Barbed dashed lines (barbs point downdip) show major reverse faults within the Seattle fault zone (Johnson et al., 1999) where it extends across southern Bainbridge Island.