Logs and Data from the Starthistle Trench Across a Scarp within the Wallula Fault Zone, Southeastern Washington

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Cover. Photograph looking southeast at the Starthistle trench site across a south-facing scarp within the Wallula Fault Zone. Photograph by Stephen Angster, U.S. Geological Survey

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Conversion Factors

U.S Customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Logs and Data from the Starthistle Trench Across a Scarp within the Wallula Fault Zone, Southeastern Washington

By Stephen J. Angster,[1] Brian L. Sherrod,[1] and John Lasher[2]

Introduction

The Wallula Fault Zone is composed of a series of northwest-trending faults and folds that coincide with a prominent magnetic anomaly that extends uninterrupted for ~120 kilometers (km) within the Cascadia back arc of southeastern Washington and northeastern Oregon (fig. 1, on map sheet; Blakely and others, 2014). It is part of the geologic structures associated with the topographic lineament known as the Olympic-Wallowa lineament (Raisz, 1945) and represents a relatively narrow zone of active faulting and seismicity that trend along the northern flank of the Horse Heaven Hills (fig. 1, on map sheet; Mann and Meyer, 1993; Schuster, 1994). Prior paleoseismic study of the Wallula Fault at an exposure at Finley Quarry indicates multiple Quaternary ruptures, including a Holocene liquefaction event (Sherrod and others, 2016), demonstrating that this fault zone poses a seismic hazard to the Tri-Cities region (Richland, Pasco, Kennewick) in southeastern Washington (fig. 1, on map sheet).

Recent airborne light detection and ranging (lidar) data coverage (Quantum Spatial 2017, 2018) east of the Columbia River reveals a ~0.5-meter-high south-facing scarp east of the Columbia River that extends, almost continuously, for ~25 km to the east along the base of the Horse Heaven Hills (fig. 2, on map sheet). As part of an effort to assess and characterize the seismic hazard posed by the Wallula Fault Zone, we excavated and studied a trench exposure across the scarp to understand its origin and the potential history of rupture along the fault zone. We present preliminary mapping and trench site information from a paleoseismic investigation. These field and laboratory data may support development of a history of the latest Pleistocene and Holocene surface rupture within the Wallula Fault Zone.

Methods

The scarp was mapped using lidar images derived from the 2017 PSLC Walla Walla Washington and Columbia Garfield Walla 2018 Lidar datasets (Quantum Spatial 2017, 2018) and field-based reconnaissance in the summer of 2019.

The trench was excavated perpendicular to the scarp by an excavator in September 2019. The east and west walls of the ~35-meter-long trench were benched for safety, providing ~1.5 meters (m) vertical exposures of both the upper and lower walls of the trench. The trench was cleaned and gridded at 1-m spacing and then photographed with scale bars for the photomosaics. Structural and stratigraphic relations of sedimentary units were flagged and then logged on photomosaics developed with structure-from-motion modeling (for example, Reitman and others, 2015; Angster and others 2016). Unit descriptions provide details and characteristics of the seven mapped units, including soil characteristics and comments on stratigraphic relations. Soil nomenclature and descriptions follow techniques and terminology described by Birkeland (1984) and the U.S. Department of Agriculture Natural Resources Conservation Service (Schoeneberger and others, 1998). Soil color was determined using Munsell soil color charts (Munsell Color, 2010). Microprobe chemical analysis and identification of a tephra sample were performed by Scott Borough at the Peter Hooper GeoAnalytical Laboratory at Washington State University. Results of chemical analysis are shown in table 1 and the source identification is discussed below.

The Starthistle Trench Site

The Starthistle trench site is located ~2.5 km east of the Columbia River on a loess-capped interfluvial surface of approximately 18–15 kilo-annum (ka) Glacial Lake Missoula outburst flood deposits (fig. 3, on map sheet; Waitt, 1985; Schuster, 1994;). At the trench site, the ~0.5-m-high scarp bounds an ~5-m-wide trough to the south. By projecting the ground surface on either side of the scarp and trough, we measure ~0.27 m of down-to-south displacement across the scarp at the trench site (fig. 3*B*, on map sheet).

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The trench exposed a sequence of rhythmically bedded sand and silt slack-water deposits (unit 1) of the Missoula Floods, which occurred around 21,400–14,300 calibrated thousand years before present (cal. yr B.P. , where present is before 1950 AD) (Waitt, 2016). Those deposits are overlain by a massive silt (unit 2) interbedded with a tephra that closely correlates (r>0.98, where r is the similarity coefficient) in chemical composition (table 1) to the Glacier Peak G tephra, 11,200 cal. yr B.P. (Kuehn and others, 2009), and thus identifying unit 2 as the L1 Loess (Busacca and others, 1992; McDonald and Busacca, 1992; Busacca and McDonald, 1994). A weak modern soil is developed within the upper ~0.5 m of unit 2 and is characterized by a <10-cm-thick A horizon (unit 2dA), a platy E horizon (unit 2cE), and a weak B horizon (unit 2aBw) distinguished by a darker stain (10YR 5/4) than the underlying unit 2a (10YR 6/3).

Large cross-cutting bodies of disorganized sand and silt (unit 3) form dike and sill structures within unit 1 and locally trace to dikes that extend into unit 2, mostly on the northern side of the scarp. The sills within unit 1 display massive to contorted bedding structure, remnant of collapsed beds of unit 1b and liquified sediment of unit 1a. Angular fragments of unit 1b form a distinct textural difference between unit 2 and the dike features. Silt-filled fractures originate from bodies of unit 3 and crosscut and locally deform beds within unit 1.

The process of scarp formation at this site remains unclear because unit 1 does not display detectable vertical offset below the scarp; rather, the bedded flood deposits gently dip (<5°) to the north, forming a gentle monoclinal fold. A series of thin fractures, which are not filled with silt, occur predominately within unit 2 at the base of the scarp and at the crest of a gentle monoclinal fold expressed within unit 1. Stratigraphic relations displayed in the trench show a distinct thickness change within the loess (unit 2) below the scarp. The liquefaction dikes that extend into unit 2 provides suggestive evidence for post-glacial ground shaking at this locality and supports the prior observations of Sherrod and others (2016) at the Finley Quarry site.

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