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PALEOEARTHQUAKE STUDY OF THE OLINGHOUSE FAULT ZONE NEAR RENO, NEVADA

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Technical abstract

The Olinghouse fault zone is a northeast trending, left-lateral fault located at the transition between the Basin and Range and Sierra Nevada in the northern Walker Lane, Nevada. A trench exposure indicates that two earthquakes have occurred since 3,400±190 cal. ybp. This implies a recurrence interval as low as 1,700 years in the latest Holocene (assuming regular return), reflecting a recent paleoearthquake activity much higher than previously assumed for the fault. Because the Olinghouse fault strikes to within 15 km of the Reno, Nevada urban area, this result has important consequences for local seismic hazard analyses.

Non-technical abstract

The Olinghouse fault zone is a northeast trending, left-lateral fault located in and along the Pah Rah range north of the Truckee River. We studied the history of large, ground-rupturing earthquakes on the Olinghouse fault by mapping fault-related features and digging a trench across the fault. We find evidence that two earthquakes have occurred since 3,400±190 years ago. This evidence suggests that the Olinghouse fault has large earthquakes more often than previously assumed. Because the Olinghouse fault strikes to within 15 km of the Reno, Nevada urban area, this result has important consequences for local seismic hazard analyses.

Final Project Summary
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Abstract

The Olinghouse fault zone is a northeast trending, left-lateral fault located at the transition between the Basin and Range and Sierra Nevada in the northern Walker Lane, Nevada. A trench exposure indicates that two earthquakes have occurred since 3,400±190 cal. ybp. This implies a recurrence interval as low as 1,700 years in the latest Holocene (assuming regular return), reflecting a recent paleoearthquake activity much higher than previously assumed for the fault. Because the Olinghouse fault strikes to within 15 km of the Reno, Nevada urban area, this result has important consequences for local seismic hazard analyses.

Introduction

The Olinghouse fault is an active, northeast-trending left-lateral strike-slip fault located within the Walker Lane, a belt of persistent late Cenozoic deformation extending over 700 km from the Mojave to the southern Cascades (Figure 1a) (Sanders and Slemmons, 1979; Stewart, 1988; Bonham and Slemmons, 1968; Grose, 1993; Pezzopane and Weldon, 1993). Recent GPS geodetic measurements indicate that 6±2 mm/year of northwest-directed, right-lateral shear, or 10-15% of relative Pacific-North America plate motion, occurs across a narrow zone directly east of the Sierra Nevada (Thatcher et al., 1999; Bennett et al., 1998, 1999; Dixon et al., 2000; Svarc et al., 2002) at the latitude corresponding to the northernmost Walker Lane and the Olinghouse fault. The Olinghouse fault is among the most active of a complex assemblage of northeast-trending left-lateral strike slip faults, north-trending normal faults, and northwest-trending right-lateral strike-slip faults which accommodate shear across the northern Walker Lane (Figure 1b). The manner in which these faults, and in particular the northeast-trending left-lateral faults such as the Olinghouse fault, accommodate the northwest-directed right-lateral shear of the northern Walker Lane is poorly understood. Here we report mapping and trench observations bearing on the style of faulting and timing of paleoearthquakes on the Olinghouse fault.

Fault location, geometry, and general neotectonic features

The active trace of the Olinghouse fault zone extends 25 km from near Tracy to Dodge Flat, where it joins the right-lateral, northwest-trending Pyramid Lake fault zone (Fig. 2). Figure 3, a neotectonic strip map along the fault, highlights geomorphic features caused by active faulting. The arcuate fault trace is discontinuous along much of its length and forms a zone up to 1 km wide. The fault displaces Tertiary volcanic bedrock of the Pah Rah Range and associated rangefront alluvium and colluvium, as well as Lake Lahontan lacustrine deposits (ca. 15.5 ka; Adams and Wesnousky, 1999) and post-Lahontan alluvium at its northeastern and southwestern extents (Figs 2, 3). Recent activity of the fault zone is reflected by scarps in young alluvium, and lateral motion along the fault has formed uphill facing scarps, enclosed depressions, and linear ridges along fault strike (Fig. 3). An offset debris flow levee preserves left-lateral displacement of 2.5 meters with a considerable normal component (Fig. 3), and apparent lateral debris flow levee and channel deflections are observed. Repeated fault displacements are preserved as successively larger offsets in progressively older surfaces.

Paleoearthquake recurrence

To investigate paleoearthquake recurrence of the Olinghouse fault, we placed a trench across a well-defined, continuous, 0.6 m (vertical separation) east-facing scarp in young alluvium along the N40E trending segment of the fault, 10 km NW of Wadsworth, Nevada (Fig 4).

Sediments exposed in the trench comprise two primary facies, a channel gravel facies and a debris flow facies (Fig 4). The occurrence of these deposits is consistent with the medial-fan location of the trench. Distinctive units are recognized on the basis of bounding unconformities and relative abundance of debris flow or channel gravel sediments. Mapped units are continuous across, and displaced by, the fault and their relative offset records discrete faulting events.

Clear stratigraphic and structural evidence for multiple slip events is exposed in the trench (Fig. 4). We interpret two events, a penultimate and most recent event. The penultimate event is associated with colluvium and muddy fill (unit 4c) capping sheared material of the eastern, better-developed fault strand. Units below this colluvium and muddy fill are offset a uniform amount. Following the penultimate event, stratigraphically highest units were partially stripped, then overlain by sediments which were then faulted in the most recent event. Units faulted in the most recent event are offset a uniformly lesser amount than those faulted by both events. Apparent thrusting of some of the uppermost units and facies mismatches across the deeper portions of the fault reflect strike-slip motion. Throughout the exposure, fault strands extend nearly to the surface, where they are capped by a thin silty vesicular (Av soil horizon) cap. The total normal component of displacement in the trench closely approximates the vertical separation seen at the ground surface.

Age control for earthquakes preserved in the trench exposure is provided by tephra and preserved organic matter (charcoal) (Fig 4). The Mount Mazama tephra (7627±150 cal. ybp; Zdanowicz et al., 1999) occurs in clean pods and lightly reworked <5 cm layers along much of the length of the trench (Fig. 4), including the fault zone. The maximum age of the twice-faulted deposits of unit 3 is 3,400±190 cal. years old, determined from AMS C-14 dating of detrital charcoal (sample C-1, Fig. 4; C-14 calibrations from Stuiver and Reimer, 1993) obtained from the muddy, non-bioturbated matrix of a debris flow layer. Thus the exposure records two events in the last 3,400±190 years. Two samples of detrital carbon obtained from colluvium deposited in a depression along the scarp after the penultimate event (unit 4c) show that the colluvium contains reworked material that is both older (sample C-4; 4130±170 cal. ybp) and younger (sample C-2; 3090±190 cal. ybp) than sample C-1.

Summary

Trench exposures of the Olinghouse fault indicate that two earthquakes have occurred since 3,400±190 cal. ybp. These results suggest a much shorter earthquake recurrence interval than previously inferred for the fault. Sanders and Slemmons (1996) estimated two or three large earthquakes in the last 21 ka on the basis of scarp degradation modeling, corresponding to a speculative recurrence interval of 8 to 16 kyr.

Evidence for lateral displacement along the Olinghouse fault zone is plentiful. Geomorphic features reflecting lateral displacement include offset debris flow levees and rock stripes, uphill facing scarps, enclosed depressions, shutter ridges, and linear ridges and mounds aligned along the fault (Fig. 3).

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Fig. 1

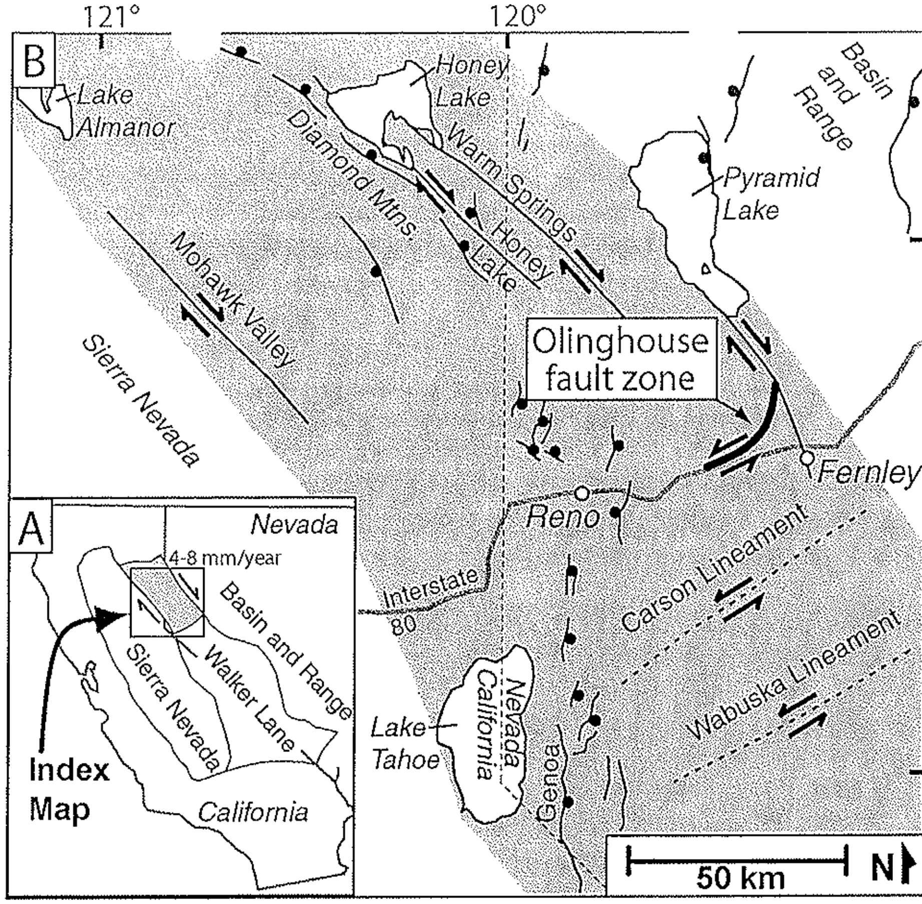

Figure 1. (A) Shaded area is the location of the northern Walker Lane. Geodetic studies show 4-8 mm/year of NW-directed, right lateral shear accumulates across the northern Walker Lane near the latitude of Reno. (B) Location of the Olinghouse fault zone. Circle is on the hanging wall of normal faults, and arrows show relative motion across strike-slip faults.

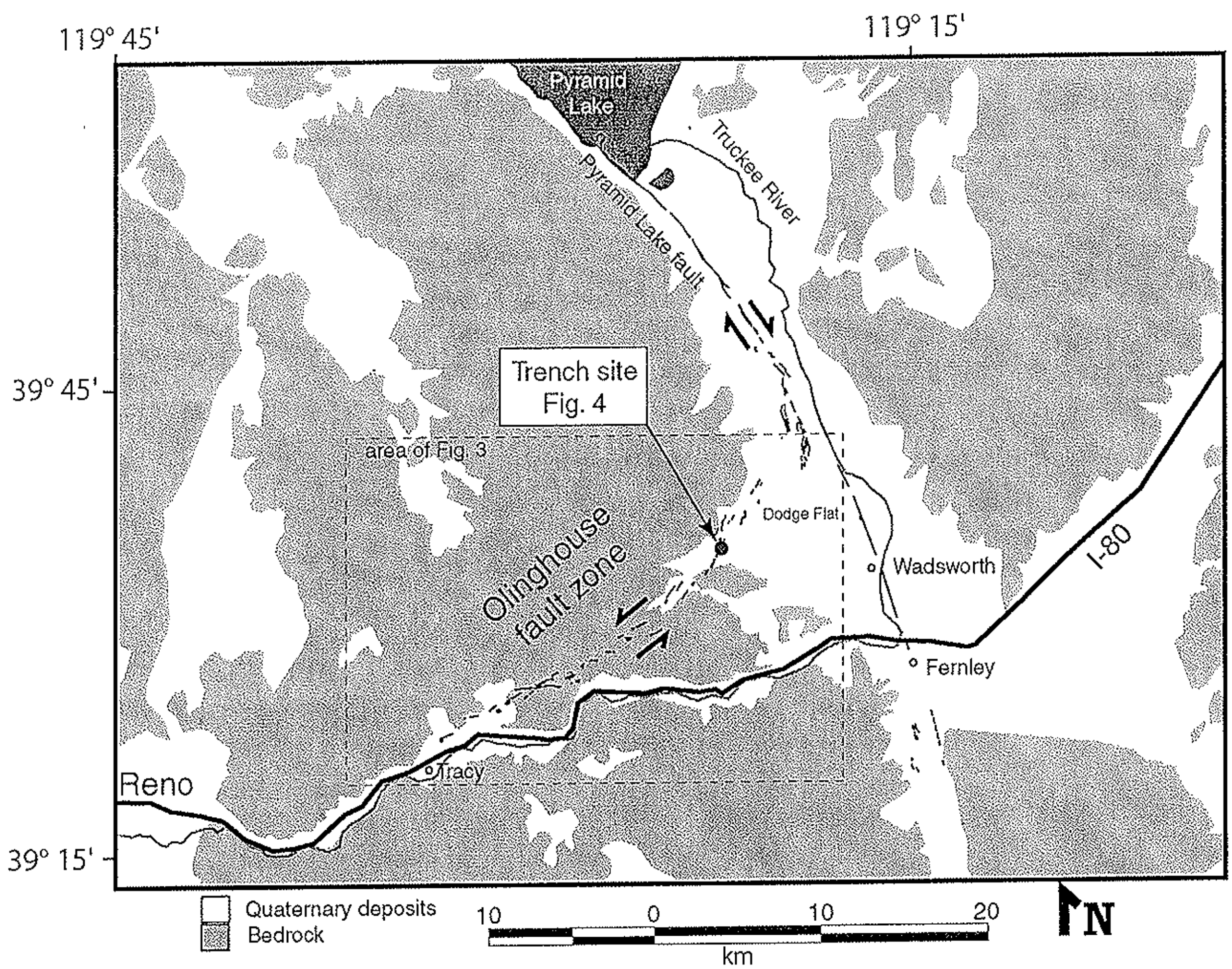

Figure 2. Location of the Olinghouse fault zone with respect to Reno, Fernley, and the Pyramid Lake fault zone.

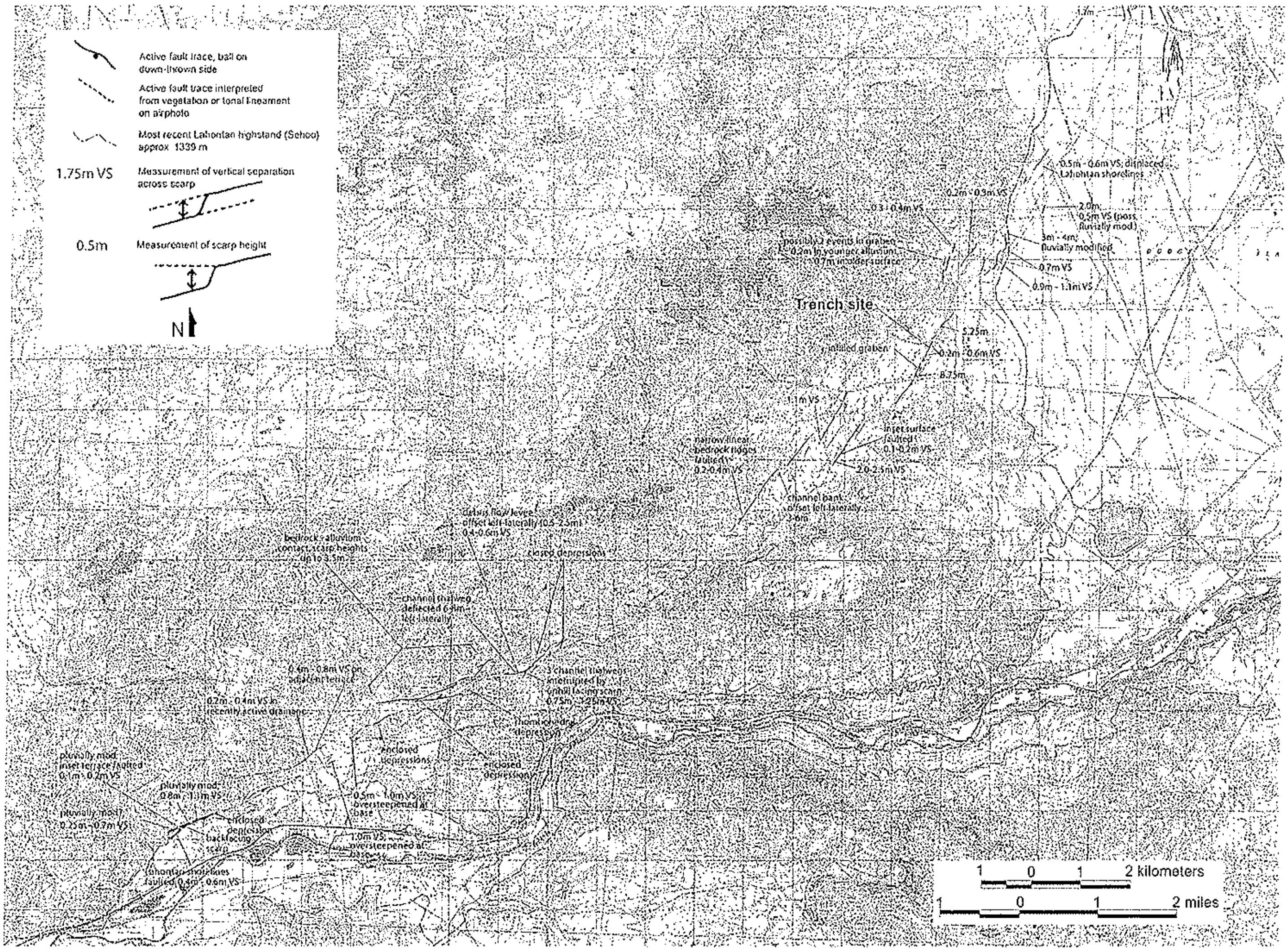

Figure 3. Strip map of Olinghouse fault zone. Location shown in Fig. 3. Base USGS 7.5' topographic quadrangles.

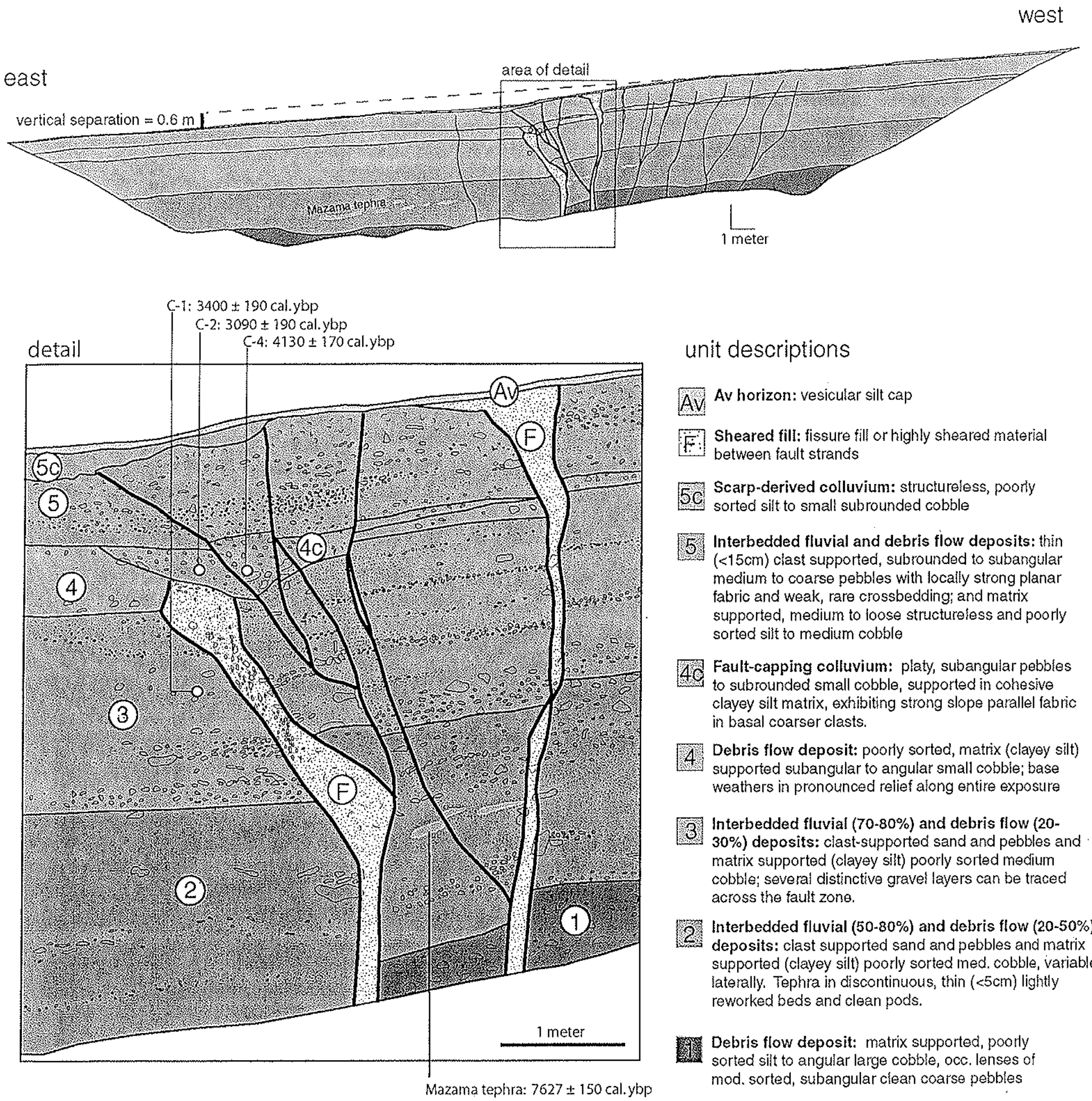

Figure 4. Olinghouse trench log. See Figs. 2, 3 for location.