Correlation of gravel deposits from trenching project on Alder Creek fluvial terrace near Point Arena, California

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ABSTRACT

Evidence of offset channel 3 of the Alder Creek fluvial terrace GPR image is supported by field interpretations and sediment attributes relating two gravel samples from trenches T-7 and T-8x2. Sieve and pipette methods were used to characterize these gravel samples. Three pairs of the samples were compared and contrasted. One pair of samples (1 and 6) had similar sediment attributes that allowed for correlation across the SAF oriented as channel 3 in the GPR image. Support from laboratory and field results indicate that the GPR image accurately represents the shallow, subsurface geology of the Alder Creek fluvial terrace.

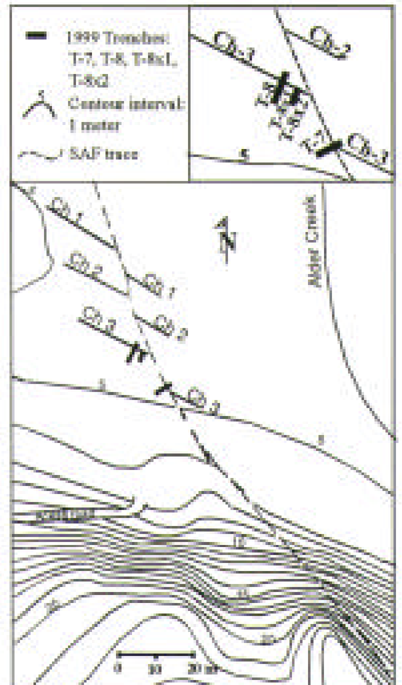

Figure 1: Alder Creek fluvial terrace trenching site. The three interpreted buried stream channels from the GPR image are shown as Ch-1, Ch-2, and Ch-3. The 1999 trenches cutting Ch-3 are T-7, T-8, T-8x1, and T-8x2.

INTRODUCTION

Past trenching investigations (Baldwin, 1996) and geomorphologic mapping (Lawson, 1908, Prentice, 1989) on the Alder Creek fluvial terrace near Point Arena, CA have identified an active-fault trace of the San Andreas Fault (SAF) through the fluvial terrace northwest to the Pacific Ocean (Figure 1). Subsurface images of the Alder Creek fluvial terrace were produced by ground-penetrating radar (GPR) for William Lettis & Associates, Inc. (1997). Interpretation of the GPR image indicated that three gravel deposits, labeled as Channels 1,2, and 3, were offset by the main SAF trace which trends approximately N45W. The 1999 trenching project at the Alder Creek fluvial terrace was designed to provide ground truth for the GPR image of channel 3.

METHODS

Field work. A TOPCON Total Station was used to map the Alder Creek trenching site.

Software. Adobe Illustrator and Adobe PhotoShop were used to scan and enhance trench logs.

Laboratory work. To characterize gravel samples, the gravimetric particle size analysis (sieve and pipette procedures) was run in the WVU Quaternary Laboratory using procedures outlined by Bell (1989).

PREVIOUS STUDIES

A strath terrace cut in Franciscan serpentenite and buried with up to 3m of channel bed gravel by Alder Creek is located in Point Arena, California. This strath terrace near Alder Creek is 17 km west of the stream's origin in the Coast Ranges and l km southwest of the stream's terminus in the Pacific Ocean. Following the 1906 earthquake, the main and a secondary trace of the SAF were recognized near the mouth of Alder Creek (Lawson, 1908). Prentice (1989) inspected Alder Creek in more detail, particularly noting the potential for matching buried channels offset by the SAF on a fluvial terrace near Point Arena. Baldwin (1996) completed a trenching project on this Alder Creek fluvial terrace yielding a slip rate of 24.5$\pm$6 mm/year. In 1997, subsurface images of the Alder Creek trench site were produce by ground- penetrating radar (GPR) (Figure 1). The GPR images were created by using transmitted waves reflected by materials in the subsurface and detected by a receiver on the surface (McCalpin, 1996). Because GPR images had rarely been applied to active fault zone studies, trenching at the Alder Creek site was necessary to provide ground truth for the image's interpretations.

PHYSICAL SETTING

Alder Creek flows west from its origin in the Coast Ranges with a more northwesterly flow near the San Andreas Fault zone. At the trench site, the fluvial terrace bears no geomorphic evidence of the San Andreas Fault trace. Immediately southeast of the trench site a northeast-facing fault scarp in a marine terrace is geomorphic evidence of the main San Andreas Fault trace. Prentice (1989) accredited the 2-meter high escarpment (which trends N32W – S58E), as juxtaposing fluvial terrace deposits to the east and marine terrace deposits to the west.

The fluvial terrace consists of 3m of Quaternary-Recent paleochannels overlying weathered and abraded Franciscan bedrock. The bedrock underlying the Alder Creek fluvial terrace is a reddish-brown colored serpentinite. Scattered throughout the bedrock are bauxite concentrations ranging between 1-20 cm in width and 10-80 cm in length within the highly sheared bedrock. The upper contact of the bedrock is abrupt and undulating with the overlying deposits of the matrix-supported gravel deposit, a clast-supported gravel, or a coarse sand.

FIELD OBSERVATIONS

Three trenches of various lengths and about 2-3 m deep were dug by backhoe. Interpretations from the first two trenches, T-7 and T-8x2, indicated discrete fluvial packages within channel 3 of the GPR image. Two distinct fluvial packages were identified:

· Youngest (Matrix-supported)	Trench T-7	Samples 1, 7	
	Trench T-8x2	Samples 5, 6	
· Oldest (Clast-supported)	Trench T-7	Sample 3	
	Trench T-8x2	Sample 4	(refer to Figure 2)

After logging T-8 and recording field observations, the southwestern section of T-8 was backfilled and eastern extension of the trench was labeled T-8x2. The first extension, T-8x1, was one meter (one bucket width of the backhoe) to the east. A juxtaposition of a coarse gravel deposit to a silty, fine-grained sand deposit, indicated a trace of the SAF. The second one meter eastern extension, T-8x2, contained evidence of the SAF trace by an abrupt juxtaposition of a gravel deposit with a coarse sand deposit. In T-8x2 the SAF was trending in a direction different from the direction previously identified by Baldwin (1996) in his subsurface/surface investigation. This direction change is interpreted as the fault stepping to the west.

RESULTS OF LABORATORY ANALYSIS

Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Trench	T-7	T-8x2	T-7	T-8x2	T-8x2	T-8x2	T-7
Median (phi)	3.5	4.9	0.7	0	2.9	4.2	2.9
Mode (phi)	4.2	4.8	2.4	0.8	3.5	4.4	3.7
Sorting (phi)	3.5	6.6	4.2	4.7	3.6	3.5	3.4
Skewness	0.2	0	0.4	0.2	0.2	0.1	0.2
Kurtosis	1	0.8	0.8	1.7	0.9	1	0.9
% Sand	54	45.3	65.7	78.1	59.2	48	60
% Silt	30	37.3	23.6	14.3	28.6	36.7	27.9
% Clay	16	17.2	10.7	7.6	12.2	15.3	12.1
Sand/Silt	1.8	1.2	2.8	5.5	2.1	1.3	2.2
Silt/Clay	1.9	2.2	2.2	1.9	2.3	2.4	2.4

Table 1: Grain-size attributes of each gravel sample.

Seven gravel deposits were sampled from trenches T-7 and T-8x2 for sedimentary analysis at the West Virginia University Quaternary Geology Lab (Table 1). The particle size distributions finer than –1 phi fraction of the seven samples were measured using dry sieve and pipette methods. Three of the seven samples were collected from trench 7 and four from trench 8x2. The samples 5,6, and 7 represent a matrix-supported paleochannel, while samples 2 and 3 are both from clast-supported, well-sorted gravels. Sample 1 was gathered from a clast supported gravel deposit overlying the matrix supported paleochannel in trench 7, and sample 4 was collected from fine-grained, clast-supported gravel at the base of trench 8x2 (Figure 2).

The results of the dry sieve and pipette gravimetric analysis indicated similar characteristics between three pairs of samples taken from different trenches (Figure 2). The characteristics determined for each sample include the percentage of sand, silt, and clay; sand /silt ratio; silt/clay ratio; kurtosis, sorting, standard deviation, and skewness. Sample 2 (Figure 2) in Trench T-8x2 had no stratigraphic counterpart in Trench T-7. The stratigraphic correlation in the field was supported by particle-size parameters:

- Samples 3 and 4
- Samples 5 and 7
- Samples 1 and 6

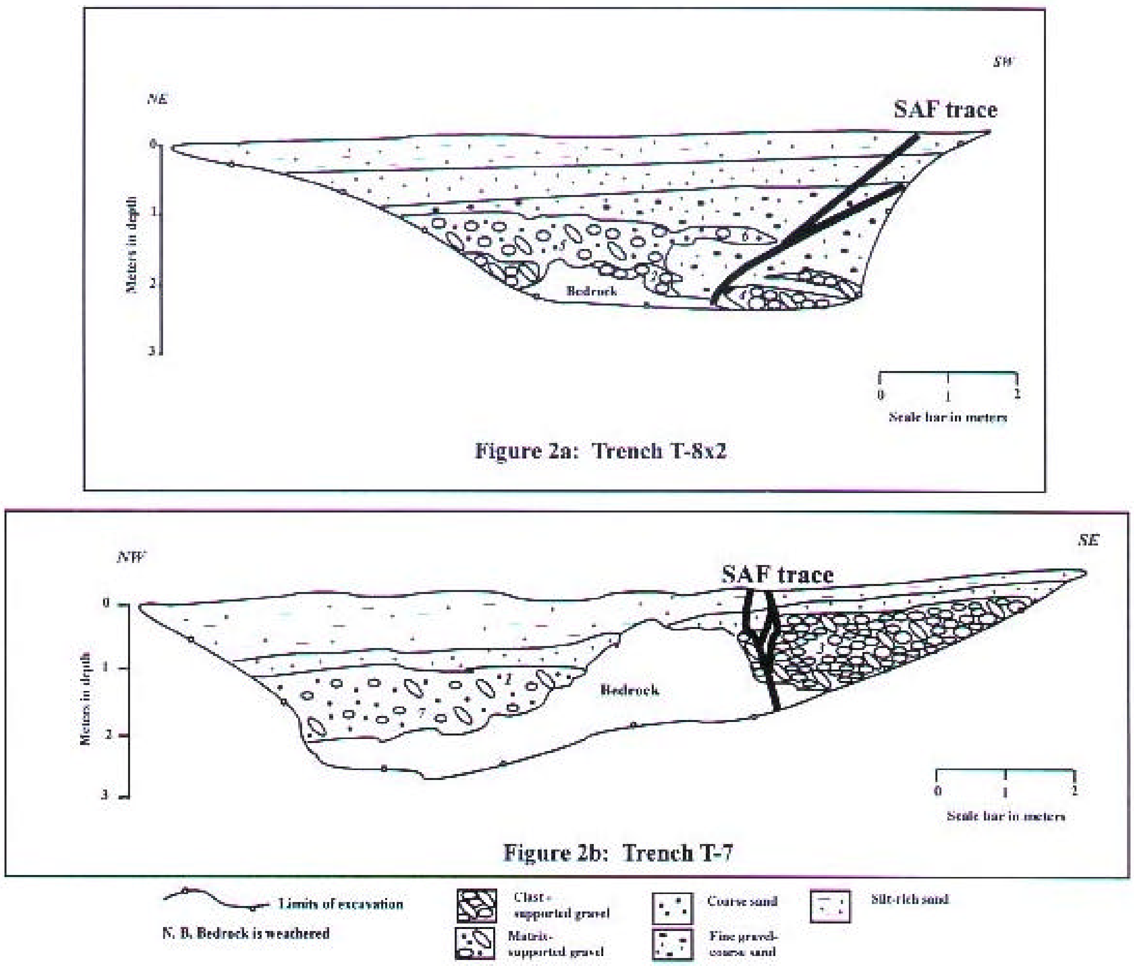

Figure 2: Trenches T-7 and T-8x2 with location of gravel samples labeled.

DISCUSSION

Typically, charcoal samples are collected within each distinct deposit in a trench for radiocarbon analysis. The radiocarbon dates are intended to support preliminary correlation between deposits in different trenches. A radiocarbon date, however, may not be an exact indication of the deposit's age, because influences other than deposition may control the placement of charcoal. Bioturbation by animals or plant fragments transported downstream from a much older plant than the timing of the stream deposition are two possible scenarios that diminish the value of radiocarbon dating. This study employs a gravimetric analysis of sand/silt/clay-size fraction of samples to provide additional correlation between the buried stream channels that have been offset by the San Andreas Fault.

The gravel samples collected from trenches T-7 and T-8x2 were identified as representing 3 different fluvial packages (Figure 2). The three pairs of gravel samples had similar attributes from the laboratory analysis. Samples 3 and 4 were the oldest pair of fluvial packages in Trenches T-7 and T-8x2.

- Sample 3 Trench T-7
- Sample 4 Trench T-8x2

Gravel sample 3 is located within the deposit disrupted by the SAF trace (Figure 2), but the fault does not interfere with the corresponding gravel deposit of sample 4 in trench T-8x2. The paleochannel that contains the deposit of samples 3 and 4 trends to the southwest; therefore, this paleochannel is not disrupted by the northwest-trending SAF between trenches T-7 and T-8x2.

Samples 5 and 7 were characterized in the field as a young, matrix-supported paleochannel. The San Andreas Fault trends to the northwest between trenches T-7 and T-8x2; therefore, the SAF trace cut through this gravel deposit.

- Sample 5 Trench T-8x2
- Sample 7 Trench T-7

Samples 1 and 6 are located on opposite sides an offset paleochannel. This pair of samples overlies the samples 5 and 7 in their respective trenches (Figure 2). The fluvial package containing samples 5 and 7 was buried by a younger stream channel containing samples 1 and 6 which represent the shallow, offset paleochannel indicated as channel 3 in the GPR image. Later, both paleochannels were offset by the northwest-southeast trending main SAF trace.

- Sample 6 Trench T-8x2
- Sample 1 Trench T-7

Sample 2 of Trench T-8x2 had particle-size characteristics similar to the attributes of sample 6 (Table 1), but not to a deposit in Trench T-7. It can be inferred that the deposit, which correlated to sample 2, was scoured out in the other trenches by younger paleochannels

CONCLUSIONS

Four trenches, T-7, T-8, T-8x1, and T-8x2, were constructed to capture the offset channel 3 of the GPR image (Figure 1). Two distinct gravel deposits were identified in each of the trenches; a younger, matrix-supported gravel deposit, samples 5, 6, 7, and 1, and an older, clast-supported gravel deposit, samples 4 and 3 (Figure 2). Laboratory analysis using sieve and pipette methods were performed on seven gravel samples from the trenches T-7 and T-8x2 to determine significant sediment attributes. The objective was to correlate the deposits across the SAF trace from trench T-7 to T-8x2. A shallow, offset fluvial package, consisting of samples 1 and 6, was the ground truth to support the GPR image's channel 3. This trenching project approved the GPR image interpretation of Channel 3.

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