PRELIMINARY RESULTS OF TRENCHING ON THE DIGDIG FAULT, NORTH CENTRAL LUZON ISLAND, PHILIPPINES

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Introduction

The Philippine Fault Zone or PFZ is a major left-lateral fault that transects the Philippine archipelago for at least 1,200 km *(Allen, 1962; Barcelona, 1986)* from northern Luzon to Mindanao (Figure 1). The origin of the PFZ is attributed in part to oblique subduction along the Philippine Trench *(Fitch, 1970; 1972)* and plays a role in the transform motion between the west-dipping subduction along the Philippine Trench and the east-dipping subduction along the Manila Trench *(Hamburger, et al., 1983)*. Based on geomorphic evidence, young left-lateral displacements were inferred in various segments of the fault *(Allen, 1962; 1975; Nakata, et alL, 1977;* and *Hirano et al. (1986)*. Slip rates along the PFZ are poorly known but probably are in the order of 1-5 mm/year *(Hirano, et al, 1986)* in north central Luzon to as much as 2-2.5 cm/year in Central Philippines *(Barrier et al, 1991)*. The Digdig Fault is the northern active splay of the PFZ as suggested by the documented youthful geomorphic features and confirmed by the appearance of a surface rupture along most part of the fault during the July 16, 1990 earthquake.

This report briefly summarizes the results of trenching conducted by a collaborative research group from the Philippine Institute of Volcanology and the Universities of Hiroshima and Tokyo. Dating of the samples was provided by Nagoya University.

The Trench Site

The geomorphology around the trench site has been previously described by *Nakata, et al. (1977; 1990)* and is shown in Figure 2. The trench site was situated along a pre-existing fault scarp along which the surface rupture of the 1990 event re-appeared.

The site is located about 400 m southeast of the junction of the Maharlika Highway and the road leading to the town proper of Caranglan, Nueva Ecija in north Central Luzon, Philippines. Four trenches were excavated but this report deals only with the second northermost trench (Trench # 3 of Figure 3) as most of the dated samples was obtained from this trench and it is here where the stratigraphic units are well-exposed.

The Trench Exposures

Five lithologic units, units A to E (from oldest to youngest) were exposed along the trench that was excavated perpendicular to the fault (Figure 4). Unit A is a 2-2.5 m thick layer consisting mostly of pebbles and boulders with silty coarse sand matrix and intercalations of coarse silty sand and very fine muddy sand lenses. This unit is truncated by all identified faulting events (I, II, and III in Figure 4). Unit B, which is in fault contact with unit A is a light brown, massive, poorly-sorted fine to very fine sand unit. Unit C which overlies both units A and B is a dark brownish-gray, poorly-sorted, silty sand unit with plant fragments and other organic materials. Unit C is overlain by Unit D and by colluvial materials. Unit D is a yellowish, massive silt to very fine sand unit whose basal portion is relatively rich in organic materials. Stringers and patches of dark gray, sandy clay appear to be liquefied. The colluvial materials are mainly derived from erosion of unit A. Unit E is a poorly-sorted, silty, carbon-rich soil with some pebbles and cobbles.

Dating Results

Table 1 is a list of samples obtained from the trench with their corresponding radiocarbon ages as determined by accelerated mass spectroscopy. The ages are given in C^{14} YBP (i.e., BP=1950). The samples consist of detrital charcoal that are conspicuously small in size and quantity. One sample was obtained from Unit D on the northern wall and two samples were taken from Unit C on the southern wall.

TABLE 1. LIST OF DATED SAMPLES FROM TRENCH # 3

Sample Number	Stratigraphic Horizon	Type of Material	Laboratory Code	Age(C^{14} YBP)
DT3 C-7	Unit C	Detrital charcoal	3149 NUTA	790+/- 80
DT3 C-9	Unit C	Detrital charcoal	3252 NUTA	1100+/-130
DT3 C-11	Unit D	Detrital charcoal	3253	480+/-130

Evidence of Seismic Events

Detailed observation of stratigraphic and structural relationships in the trench indicates that at least two, and possibly three, seismic events including the 1990 event could be identified. The 1990 event is clearly expressed as a linear vertical structure trending N 10° W that truncates units A-D in both walls of the trench (Figure 4). This event is indirectly dated from the age of unit D which overlies the colluvium, assuming that the timing of deposition of layer D does not significantly vary from the age of colluvium formation. Thus, this event probably occurred between 1340-1600 A.D. The penultimate event, on the other hand, is marked by the formation of scarp-derived colluvial wedge and by the tilting and degree of deformation of units A-C. This event apparently ruptured along the same zone as the 1990 event. The presence of an older event is indicated by the abrupt termination of unit A, but its timing is more difficult to constrain as it was evidently affected by erosion and subsequent deposition of units B and C. Based on two ages obtained from Unit C which directly overlies the uppermost portion of faulted unit A, this event could have occurred between 710-1240 A. D.

Implications

Despite the limited number of dated materials, the trenching results suggest a number of interesting points. The 1645 earthquake which affected a large part of Luzon island is an attractive candidate for the penultimate event recognized in this study considering the proximity of the younger radiocarbon age of 1640 to the 1645 event. Prior to this study, *Hirano et. al (1986)* and *Nakata, et al. (1990)* suggested that the 1645 event did not involve the Digdig Fault segment but was restricted mainly to the Gabaldon segment further to the southeast. However, if the penultimate event documented in this study is actually the 1645 earthquake, then this event could be comparable to the 1990 earthquake in terms of length of rupture, magnitude, and possibly, even the associated displacements. In this scenario, the Digdig segment of the PFZ will have a relatively short recurrence interval (345-405 years, assuming that the penultimate event is the 1645 earthquake and taking the younger age of 1240 A.D. as the oldest seismic event) and relatively high slip rates in the order of 1-2 cm/year (using 5-6 m horizontal displacements as measured during the 1990 earthquake). These values, although quite tenuous without additional dates and other data, present an interesting area for further research as it could have serious implications to earthquake hazards assessment related to future activity of the Digdig Fault.

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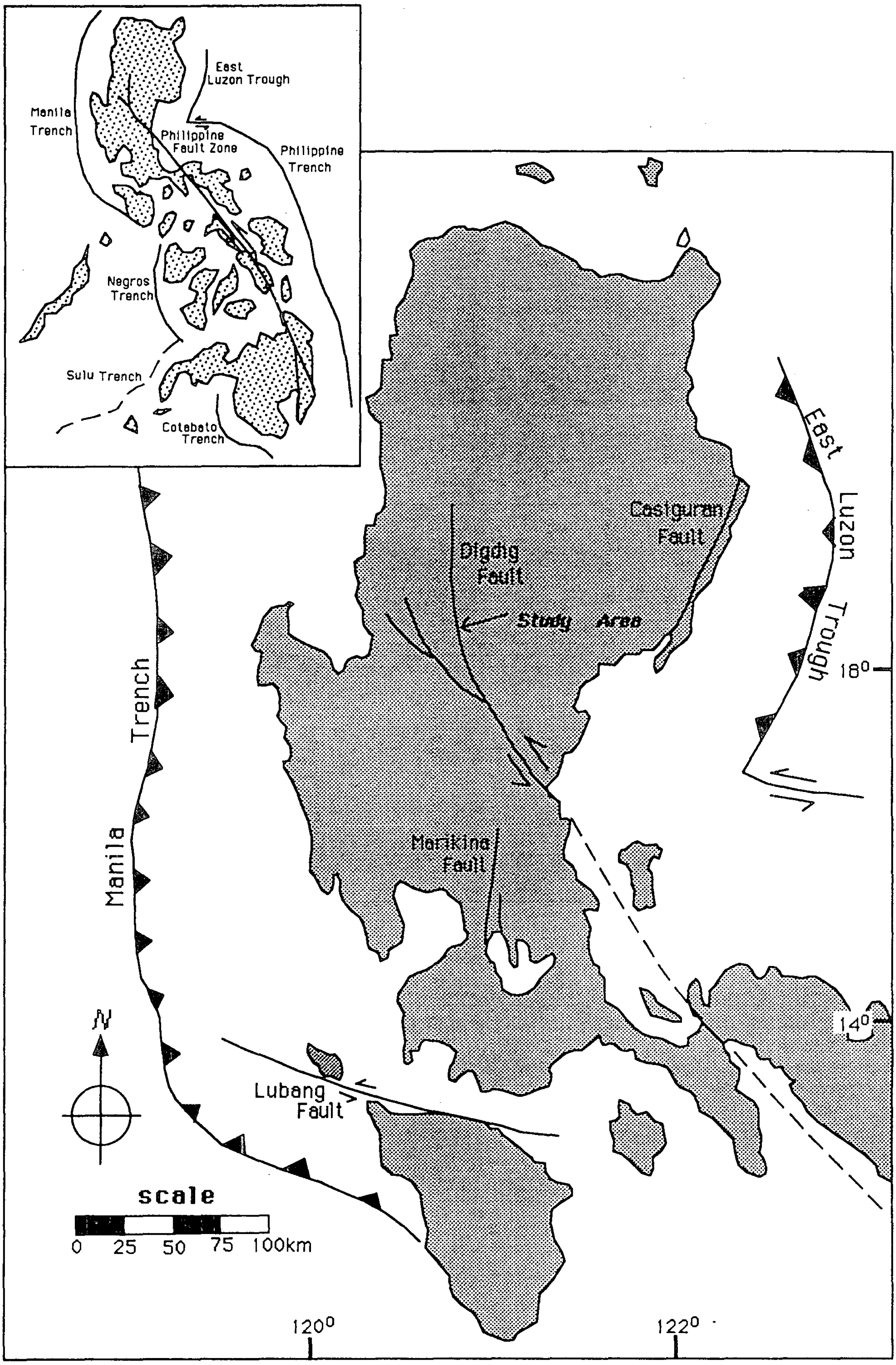

Figure 1. The Philippine Fault Zone and other major tectonic structures in Luzon island, Philippines.

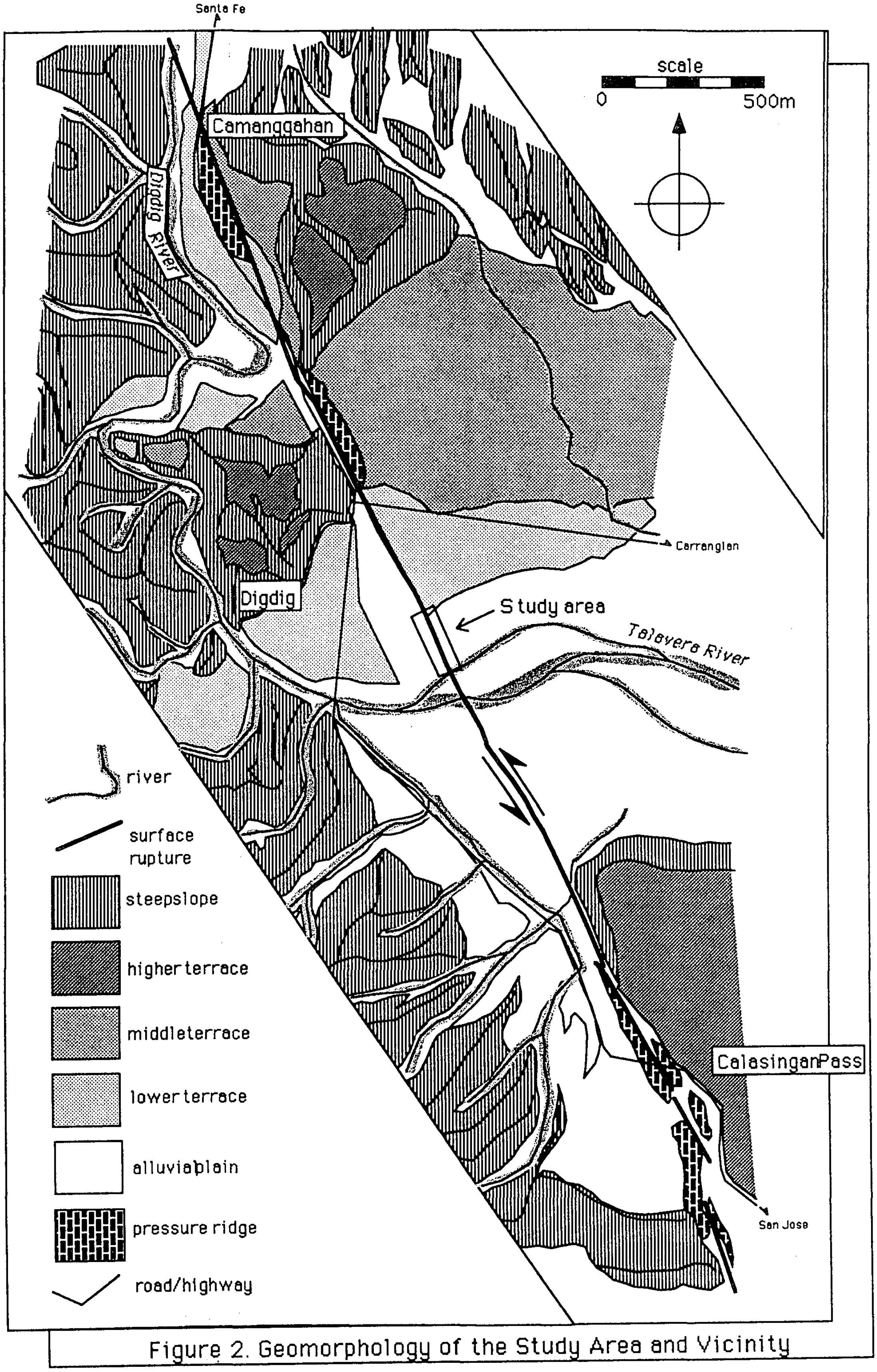

Figure 2. Geomorphology of the Study Area and Vicinity

(Modified from Nakata, et al, 1990)

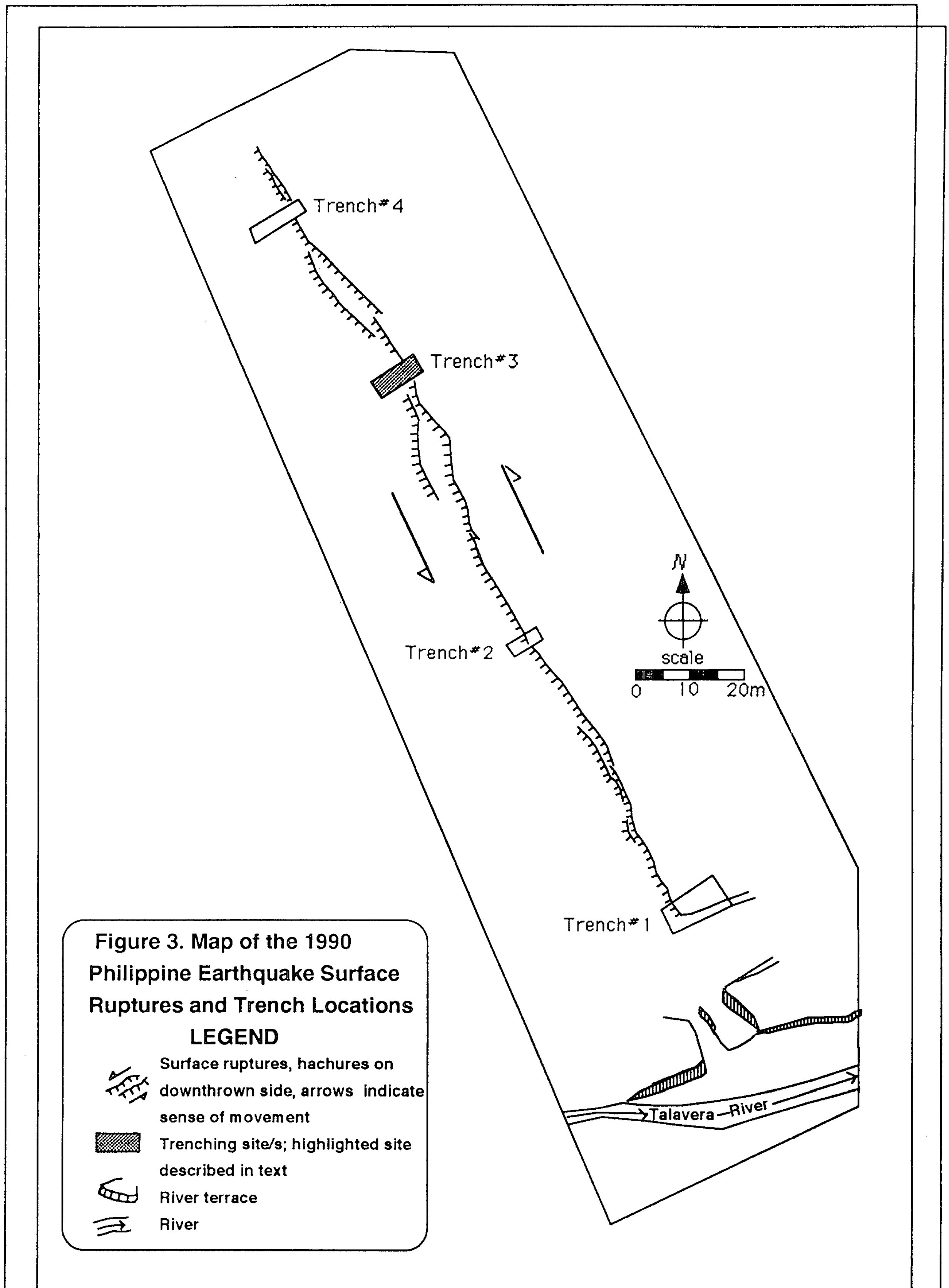

Figure 3. Map of the 1990 Philippine Earthquake Surface Ruptures and Trench Locations

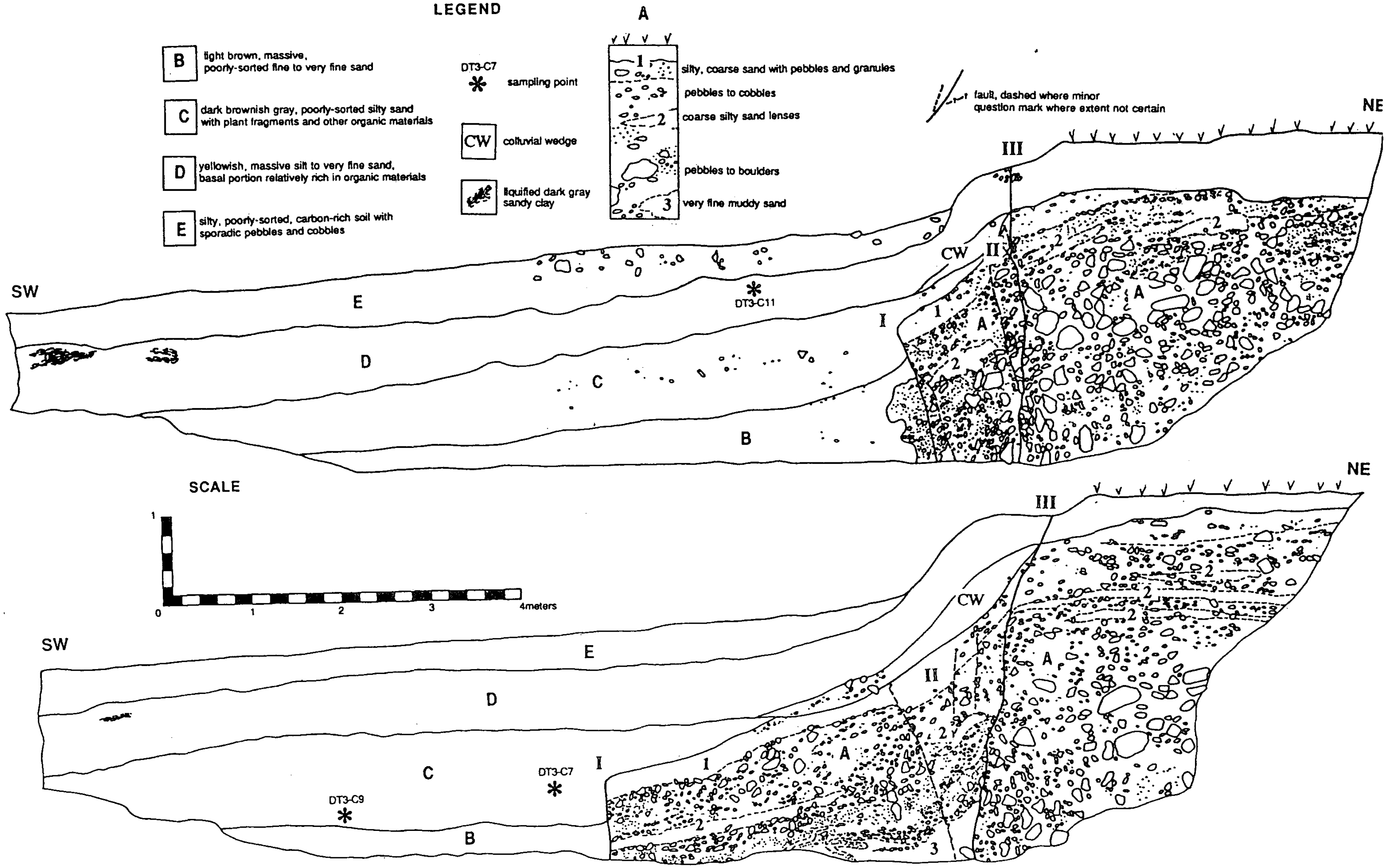

Figure 4. Cross-section of the northern (upper figure) and southern (lower figure) walls of trench # 3. The southern wall is shown as a through the sediment section. The events, from oldest to youngest are marked as I, II, and III, respectively. See legend and text for details.