Dip slip is the main mechanism of earthquakes in the Lower Rhine area. Most hypocenters can be attributed to the main faults of the area, which evidently extend deep into the crust or even cut through the crust completely. The mean seismotectonic dislocation rate, determined from historical earthquakes, is in the order of 1 mm in 100 years at most. Geologically determined rates of movement are an order of magnitude larger and can only be explained by creep, or seismically by stronger earthquakes of magnitude 7 or more.

PALEOSEISMOLOGICAL INVESTIGATION OF THE FELDBISS FAULT IN BELGIUM

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Since 1996 the Royal Observatory of Belgium is carrying out a paleoseismological investigation of the Belgian portion of the Feldbiss Fault, the southwestern boundary fault of the Roer Valley Graben. Paleoseismology is a relatively young branch of geology aimed at the search of traces of «fossil» earthquakes, evidenced by surface rupture and/or soft-sediment deformation preserved in relatively young (late Pleistocene and Holocene) sediments. Shallow excavations allow to identify, and possibly date such deformation, and thus to demonstrate the occurrence of large past earthquakes, either historic or prehistoric. This provides valuable information concerning the seismic cycle of the given fault segment, complementing our current knowledge that is only based on ca. 100 years of instrumental recording and ca. 1000 years of reliable historical records.

Geomorphologically, the Feldbiss Fault is well defined as a fairly rectilinear, NW-SE oriented escarpment between the towns of Bree and Neeroeteren (Fig. 1). This escarpment corresponds to the northeastern limit of the Campine Plateau, and is characterised by a denivellation of 15 to 20 m. The tectonic nature of this escarpment has already been recognised since the beginning of the 20th century, and was confirmed by the study of terrace deposits (Paulissen, 1973), as well as by deep seismic reflection profiles (Demyttenaere & Laga, 1988). However, the potentiel active character of this fault has not been considered.

Detailed geomorphological mapping reveals that in most places along the escarpment, which is now referred to as the Bree Fault Escarpment a smaller frontal escarpment can be recognised, which is considered to be the expression of recent surface rupture(s) (Camelbeeck & Meghraoui, 1996). In order to prove this hypothesis, three sites (location in Fig. 1) have so far been investigated in more detail: in a first step, geophysical profiles (electrical resistivity and electromagnetic measurements, electrical tomography and ground-penetrating radar) were collected perpendicular to the scarp, all indicating shallow disturbances of the stratigraphy. In a second step, shallow trenches (2 - 3.5 m deep, 60 - 80 m long) were excavated across the frontal escarpment. The results are here briefly summarised for the two first sites, which are located very close to each other, in the axis and on the shoulder, respectively, of a small river valley incising the Bree fault scarp near its northwestern limit (Fig. 1).

The trench profile in site 1 is dominated by a homogeneous, structureless sand layer, the top of which is in most places reduced. Within the sand layer, two thin gravel horizons can be discerned, both showing a vertical displacement of about 0.6 m (Fig. 2). This discontinuity is exactly aligned with the frontal escarpment at the surface, and with the geophysical anomalies at depth. A second argument for the fault's existence is found in the larger thickness of the reduced top layer in the downthrown block, which also indicates that the displacement occurred more recently than the main phase of Holocene soil development; erosion removed part of the reduced soil horizon from the elevated block. ^{14}C-dating of preserved plant material yields an age of 1000 - 1350 years for this recentmost surface rupturing event.

The stratigraphie log of site 2 (Fig. 3) is characterised by older sediments and much larger deformation. On the upper part of the slope a thick layer of brown-oxidised gravel, belonging to the main middle Pleistocene (350 - 700 ka) terrace of the Meuse river covering the Campine plateau (Zutendaal Gravel, Paulissen, 1973), is laterally truncated by a fault, and displaced to below the reach of the trench. This fault almost extends up to the ground surface, and again coincides with the position of a small topographical escarpment. Immediately downslope of this fault, the sediments consist of a complex series of silty and sandy units rich in gravel, interpreted as several generations of colluvial wedges (Camelbeeck & Meghraoui, 1998). A second fault branch, characterised by parallel aligned pebbles over a width of 0.5 m, cuts through some of these wedges as well, illustrating the repetitive character of the faulting. In addition, the sediment layers in the downthrown block appear to be affected by various intraformational soft-sediment deformation features, including:

- meso-scale asymmetric folding;
- small-scale normal faults, mostly dipping towards the upper slope;
- small water escape or load features (convolute lamination, flame structures, ...);
- possible sand blows.

Most of these features are thought to be the result of partial or full liquefaction induced by earthquake shocks, though further research is needed to confidently distinguish them from possible cryoturbation effects. Similar phenomena have been observed during recent strong earthquakes, and notably during the Roermond earthquake in 1992 (Davenport et al., 1994). Their presence provides additional evidence for the co-seismic nature of the observed surface ruptures. Stratigraphical relationships indicate that the deformation in trench 2 is related to several deformation events, but their chronology remains rather speculative. In the fault zone, three colluvial wedges are recognised, each corresponding to a surface rupturing event, whereas there is evidence for at least four phases of soft-sediment deformation since deposition of a virtually undeformed clay band having a ^{14}C age between 25 and 35 ka (see Fig. 3).

The paleoseismological investigation of the Feldbiss Fault in Belgium is not yet completed, and in particular the datings need to be confirmed. However, evidence has been found for the occurrence of at least one Holocene surface rupturing earthquake with an estimated moment magnitude M_w 6.3 (Camelbeeck & Meghraoui, 1998).

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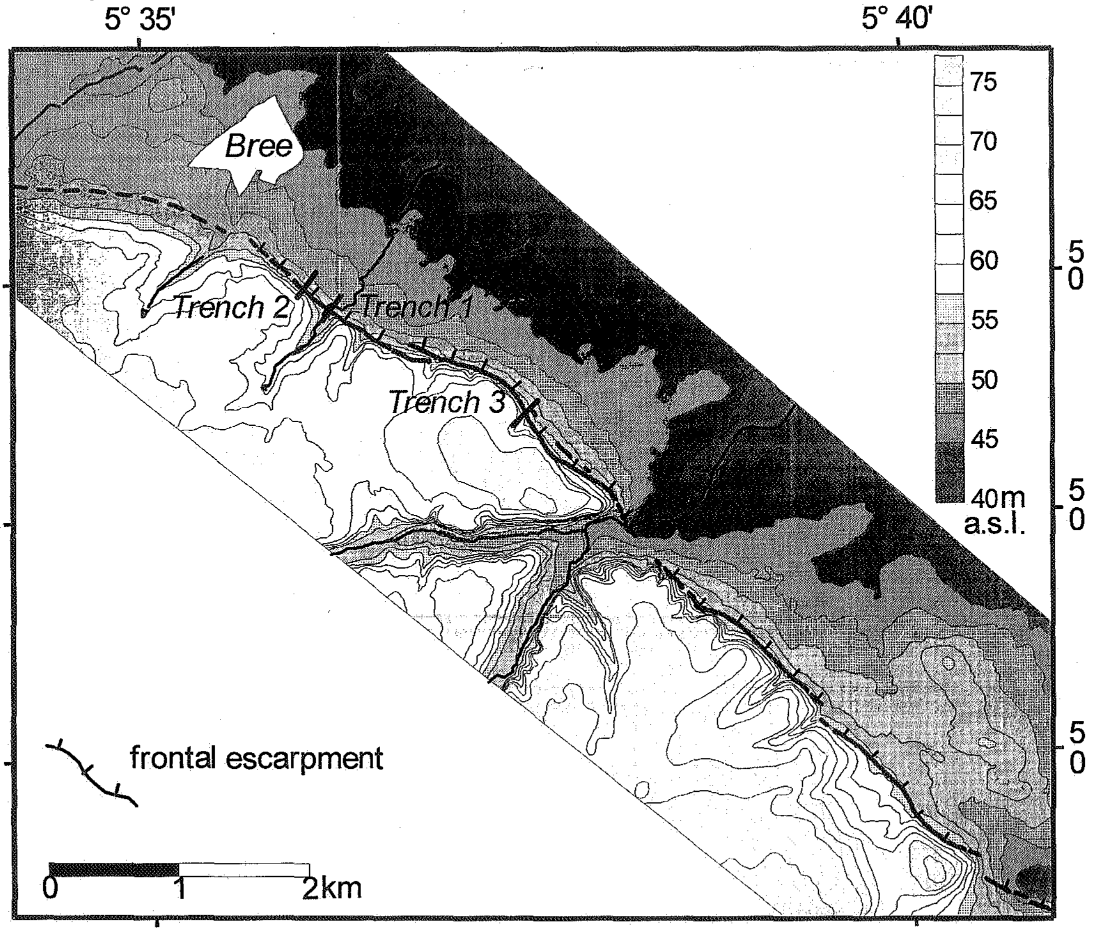

Figure - CAMELBEECK - MEUSE

Figure 1. *Morphotectonic map of the Bree fault escarpment, showing position of the frontal escarpment and location of the trench sites.*

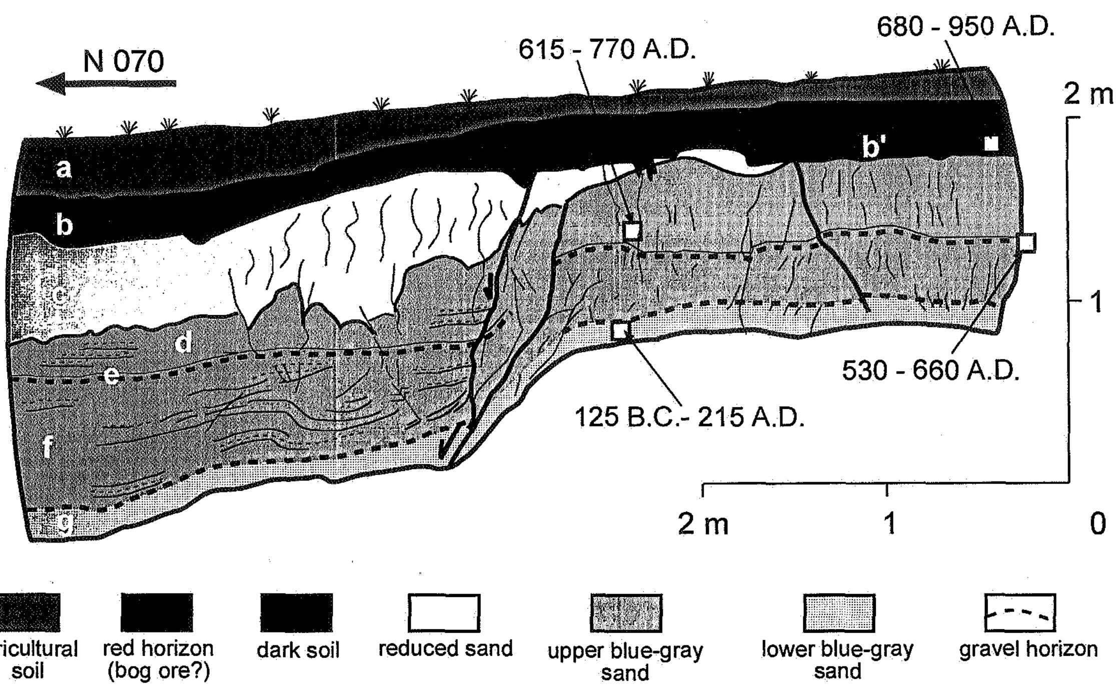

Figure 2. *Sediment log of the fault zone in trench 1.*

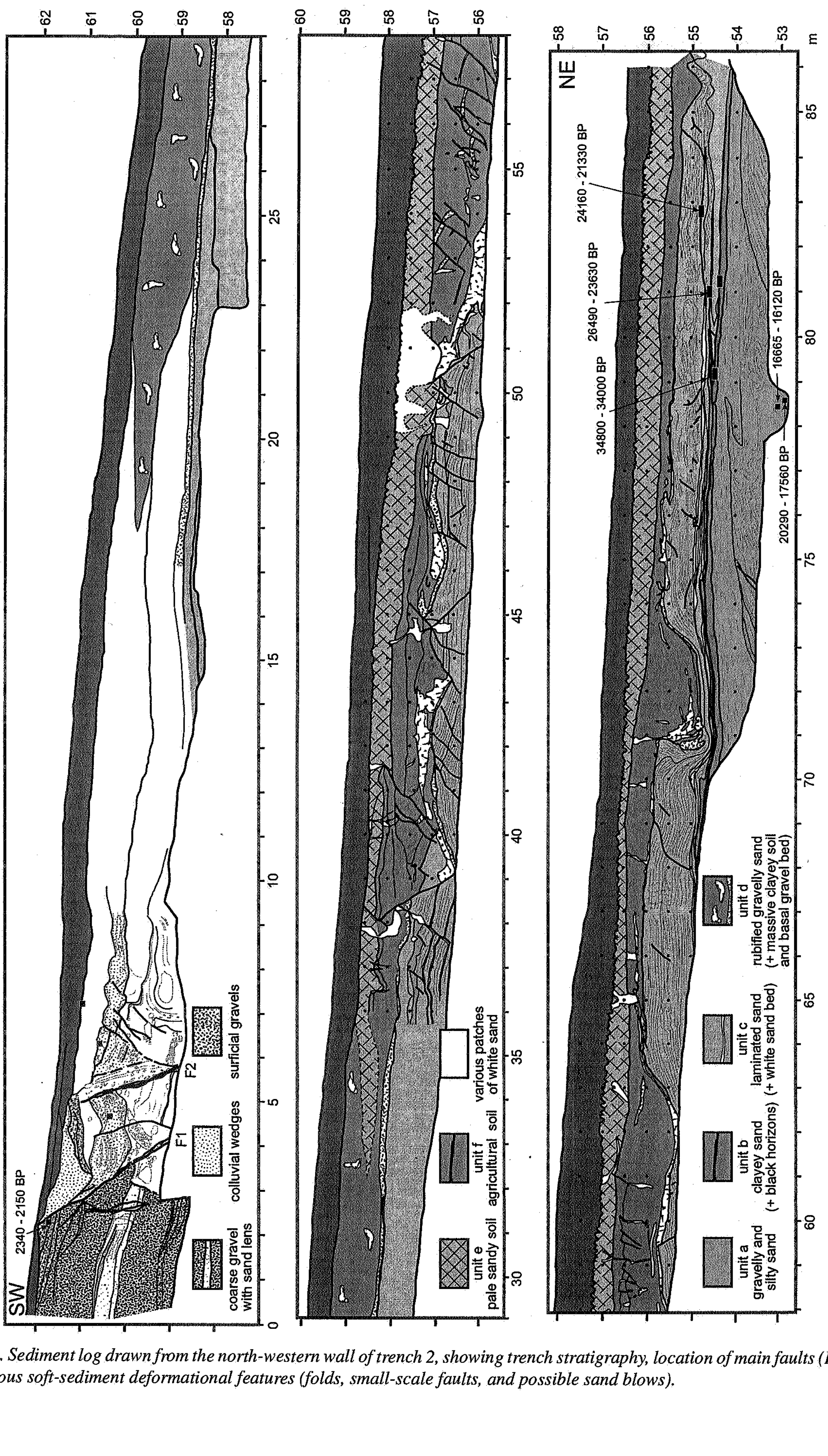

Figure 3. Sediment log drawn from the north-western wall of trench 2, showing trench stratigraphy, location of main faults (F1, F2), and various soft-sediment deformational features (folds, small-scale faults, and possible sand blows).