Geophysical Research Abstracts, Vol. 9, 06005, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06005

Relevance of geodetic, seismicity and active faulting studies to assess lithospheric deformation and long-term earthquake activity in intraplate Northwest Europe

T. Camelbeeck (1), K. Vanneste (1), P. Alexandre (1), C. Bruyninx (1) and M. Van Camp (1)

(1) Royal Observatory of Belgium (thierry.camelbeeck@oma.be)

We discuss the contribution of geodesy, seismology and geology to provide reliable information on the recent deformation in the region of Northwest Europe between the Lower Rhine Embayment and the North Sea. To characterize the slip on active faults in the Lower Rhine Embayment, we are conducting CGPS measurements across the western border fault of the Roer Graben since 1997. These do not show any observable relative movement larger than 0.5 mm/yr for the vertical component and 0.3 mm/yr for the horizontal one. These results suggest that vertical movements previously deduced from the comparison of first-order levelling surveys have to be considered with a critical eye. In the Ardenne and the Eifel, the analysis of repeated levelling suggests a present-day uplift of 1-2 mm/yr which contradicts the vertical rate of 0.1 mm/yr suggested by river incision during the Quaternary. We consider that this present-day uplift remains an open question. For that reason, we created in 1999 a profile of absolute gravity (AG) measurements across the Ardenne to infer vertical movements. This eight-station profile is 140 km long and is performed twice a year. Presently, the gravity variations are not yet significant, but the inferred trends for the resulting vertical movements are mostly negative (approx. -1 mm/yr) and agree with glacial isostatic adjustment models. Thus, deformation in active tectonic structures in northwest Europe is close to or below the accuracy of current space and ground-based geodetic techniques. It will be necessary to have longer periods of observation before interpreting them. Re-evaluated historical earthquakes and present-day seismological data indicate that an important part of the known seismic activity is concentrated in the Roer

Graben. Nevertheless, the three strongest known earthquakes with estimated magnitude equal to or greater than 6.0 occurred outside of this active structure, respectively in the northern Ardenne (18 September 1692), the southern North Sea (21 May 1382) and the Strait of Dover (6 April 1580). Thus, these earthquakes can explain the very low (basically unknown) recent geologic strain rates in these regions and could be considered as the largest earthquakes to occur in these areas. On the other hand, in the Roer Graben, the only region where recent geological deformation rates have been estimated, the largest known historical earthquake has a magnitude of 5.7 (18 February 1756). If the observed deformation during the late Pleistocene and the Holocene is to be explained only by earthquake activity, large earthquakes affecting the whole seismogenic layer should occur. Our paleoseismic investigations along the Bree fault scarp provide evidence that such large earthquakes did occur during the recent past, and that even in Northwest Europe the earthquake activity can be sufficiently important to generate large-scale geological structures. The most recent large seismic event is even well expressed in the morphology as a small scarplet with a ˜ 0.5 m vertical offset that can be traced along the 10 km of scarp. The synthesis of the paleoseismic data allows us to calculate the fault slip rate and return period for large earthquakes on the Bree fault scarp. If we consider the two most recent complete earthquake cycles, which are best constrained in time and can be correlated across the entire fault scarp; we obtain an average return period of 13.7 ś 7.8 kyr. The average fault slip rate is 0.050 ś 0.036 mm/yr.