Geophysical Research Abstracts,
Vol. 11, EGU2009-3938, 2009
EGU General Assembly 2009

Crustal Deformation in Stable Continental Europe: a Comparison of Seismicity, Geodetic and Geologic Information

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Evaluating the maximum magnitude and the recurrence of large earthquakes depend on where and how the strain is released in the lithosphere. Therefore, to characterize the long term seismic activity in northwest Europe (NWE), we evaluated and compared the strain accumulated by the known seismic activity with that observed in the recent geological record and that deduced from geodetic data.
The consistent re-analysis of GPS data collected by a selection of the EUREF (since 1996), and WALCORS and FLEPOS permanent networks (since 2003) does not evidence horizontal crustal movements greater than the uncertainties, and does not allow identifying regions with strain accumulation. Nevertheless, GPS-based velocities constrain the maximum value of the present horizontal strain rates to around 5 $10^{10} yr^{-1}$.
The evaluation of the scalar seismic moment release during historical times suggests that in western and NW Europe, M $\geq$ 6.5 - 7.0 earthquakes should be very rare, and that the seismic strain is relaxed by numerous moderate earthquakes with magnitude between 5.5 and 6.0. However, the strongest physical constraints on these assumptions will come with the improved precision of the GPS site velocities as the observation time series become longer. The earthquake moment release in NWE during the historical period (the last 700 years) is of the order of 10^{16} N.m/yr, which corresponds roughly to 40% of the possible maximum geodetic strain rate for the whole intraplate Europe. An evaluation of the moment release by the active faults in the Lower Rhine Graben system for the last 10,000 years provides also a value around 10^{16} N.m/yr. More specific studies should be undertaken to confirm these numbers, but they already suggest that, on the long term, the Lower Rhine Graben system relaxes an important part of the strain in this part of intraplate Europe.
Repeated absolute gravity measurements across the Belgian Ardenne and the Lower Rhine Graben system, and in Oostende, on the Belgian coast, suggest that the whole region is presently subsiding at a rate of 1-2 mm/yr, in agreement with the most recent published model of the glacial isostatic adjustment (GIA).
The GIA models, validated by geodetic data in the most uplifted area of Fennoscandia GIA, suggest a NNE-SSW compressive strain in northwest Europe, which is in contradiction with the strain deduced from earthquake fault-plane solutions and the geological observations in the Lower Rhine Graben system. This questions the possible relationships between earthquake activity and GIA.