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Active deformation of an intracontinental region inferred from seismic pattern and numerical modeling

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An unresolved problem in seismology concerns the occurrence of unexpectedly strong earthquakes within intraplate slow deforming regions such as Central Asia, Western United States and Western Europe. These earthquakes can be damaging as the 1811 and 1812 New Madrid events of Mw = 8.1 and 8.2, in a region where the instrumental seismicity level is very low and where the deformation is almost not detectable by GPS. The historical seismicity of western Europe is similar (Bâle 1356, Roquebilière 1564, Lambesc 1909…), revealing the same paradox (strong magnitude, small deformation). Moreover, Western France has been struck by a moderate, but unexpectedly strong (M_L = 5.7), earthquake the 30th of September 2002. In order to improve the seismic risk assessment, we studied the seismic pattern and modeled strain concentrations in this area where we dispose of valuable seismicity catalogues, good geological knowledge and recent geophysical results. First, we revised the seismotectonics, which was made possible by the increase of permanent seismological stations. Then we determined the stress field by inversion of new focal mechanisms. We evidence a regionally significant NW trending sigma 1 strike-slip regime overprinted by local extensional perturbations in three distinct areas. Focusing on the westernmost of these perturbations, we show by mechanical modeling (elastic/visco-elastic stress transfer code VISCO1D, Pollitz 1997) that the forces associated with the subduction of the Bay of Biscay (between France and Spain) are strong enough to trigger moderate earthquakes in the western coast of France. Therefore, we suggest that it is a possible mechanism for the origin of stress concentrations associated with the strongest earthquakes of western France. Then, we have study the precise mechanisms of stress concentrations by 3D thermomechanical modeling (finite element ADELI3D code, Chéry et al., 2001), taking into account structural, thermal and rheological parameters.

References

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