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Comparing the New Madrid Seismic Zone with the Osning Thrust: implications for GIA-induced intraplate tectonics in northern Germany

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Continental intraplate tectonics is a widespread phenomenon that causes significant earthquakes. These earthquakes even occur in areas that are characterized by low strain rates and there are often long intervals between the individual seismic events (Gangopadhyay & Talwani, 2003) that result in a hazard potential. To better understand the controlling factors of intraplate plate earthquakes in northern Germany, we compare the Osning Thrust with the intensively-studied New Madrid Seismic Zone in the Midwest USA. Both areas share major similarities such as a failed rift-basin setting, the presence of intrusive magmatic bodies in the subsurface, tectonic reactivation during the Late Cretaceous, paleo- and historic seismicity and comparable fault parameters. In addition, both areas have a very similar Late Pleistocene deglaciation history. New Madrid was c. 340 km south of the Laurentide ice sheet and ice retreat started around 21 ka and was completed by 8.5 ka (Grollimund & Zoback, 2001). The Osning Thrust was c. 310 km south of the Scandinavian ice sheet and deglaciation began at 24 ka. Both areas show historic seismicity in a similar time frame (New Madrid Seismic Zone: 1811-1812, Johnston & Schweig, 1996); Osning Thrust: 1612 and 1767, Grünthal & Bosse, 1997). We use numerical simulations to identify the timing of potentially GIA-induced fault activity, which are based on the fault stability margin concept of Wu & Hasegawa (1996). From our modelling results it is evident that the fault stability margin changed to negative between 16 and 13 ka for the Osning Thrust, which matches the OSL data of fault-related growth strata (Brandes et al., 2012). For the New Madrid Seismic Zone, the fault stability margin becomes zero between 2.5 ka BP (before 1812) to about 2 ka after the 1812 event, depending on the parameters of the model. This indicates that for both seismic zones, seismicity due to deglaciation was and still is very likely. From this study it can be derived that earthquakes are common if typical intraplate tectonic prerequisites, such as large faults with a polyphase history and magmatic bodies that can act as stress concentrators, are overprinted by GIA movements.

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