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Strong paleoseismic manifestations in the south Baltic Sea basin, Kaliningrad city area, related to the retreat of the Fennoscandian Ice Sheet

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Evidence of Mw >7-8 paleo-earthquakes accompanying final deglaciation across Fennoscandia and North America indicates enhanced seismicity close to the retreating margins of former ice sheets. Many of these high-latitude continental regions are currently characterized by moderate seismicity with typical magnitudes of Mw≈4-5. The relation between modern seismicity and former glaciations through ongoing isostatic adjustment is, however, a subject of considerable debate. Here we report and interpret new data on paleo- and contemporary earthquakes in one of the least studied regions formerly covered by the Fennoscandian Ice Sheet (FIS), namely the Kaliningrad area. According to paleoseismic evidence, an earthquake with a magnitude of Mw $\geq$ 7 occurred in this region about 11$\pm$0.5 ka ago. The age of the resulting paleoseismic ruptures (landslides, marks of liquefaction, seismites, close-to-fault folding) was determined by radiocarbon dating. Comparison with the reconstructed extent of FIS from glacial geomorphology reveals that the timing of this strong event, within dating uncertainty, coincides with the timing of local deglaciation. In this period, the ice margin across the south-eastern Baltic Sea region had retreated to allow, in succession, the Yoldia Sea, Ancylus Lake and the Littorina Sea to emerge. Because sediments previously covered by ice became oversaturated with water from the Yoldia Sea, the seismic shaking of the Mw $\geq$ 7 earthquake produced gravitational ruptures, which were found during our field investigations. Several seismic events have been registered using instrumental observations in the 20^{th} and early 21^{st} centuries. The latest earthquake occurred in Kaliningrad in 2004 with Mw 4.8, following a foreshock of Mw 4.6. The epicenter area was studied using seismotectonic and seismological methods immediately after the event. We identified some active faults responsible for the generation of the 2004 events, revealing that several moderate seismic events happened in the same source zone during the 14^{th} century, and 1160$\pm$90 and 2970$\pm$80 years ago, and found additional evidence for Late Pleistocene and Early Holocene major earthquakes on the Sambian Peninsula. The magnitudes (up to 6) and intensities (up to VIII on the MSK-64 scale) of the recent paleoearthquakes were much lower than those from the Late Pleistocene and Early Holocene. Although the timing and magnitudes of paleoearthquakes dated to the Late Pleistocene - Early Holocene argue in favor of initiation by glacial isostatic bedrock adjustment, focal mechanisms of 2004 earthquakes indicate that the ongoing postglacial rebound is unlikely to be the major mechanism controlling modern seismicity in this region.