Geophysical Research Abstracts
Vol. 15, EGU2013-489, 2013
EGU General Assembly 2013

Implementing faults in finite-element glacial isostatic adjustment models

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Flexural stresses induced in the lithosphere during glaciation started to trigger earthquakes along pre-existing faults near the end of the deglaciation. To gain a better understanding of the relationship between glacial loading/unloading and seismic activity, a model for glacial isostatic adjustment (GIA) is extended by inclusion of a fault structure. Solving this problem involves the development of three models using the finite-element method. The first model estimates the displacement and stress conditions during and after the glaciation of an ice sheet. These values are used to evaluate the fault stability, and generate a second and third model. The second model relates realistic displacement with stress conditions incorporating the rebound stress, tectonic background stress, and lithostatic stress, and is used to estimate reaction forces to hold the model in equilibrium. The same initial conditions as for the second model are used again for the third model, together with the reaction forces. The fault is able to move, and the fault throw can be estimated.
The results show stable conditions along the fault during glaciation and deglaciation. After the end of the deglaciation period, the fault starts to move, and offsets of up to 30 m are obtained for a fault at the centre of the ice sheet. Depending on the fault angle, the fault shows further activity in the following 5,000 years. In all cases, a thrusting/reverse sense of the fault is obtained.