Geophysical Research Abstracts
Vol. 14, EGU2012-10762, 2012
EGU General Assembly 2012

Rifting, heat flux, and water availability beneath the catchment of Pine Island Glacier

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The West Antarctic Rift System (WARS) is a major rift system that developed in the Cretaceous and Cenozoic. It forms the lithsopheric cradle for the marine-based, and potentially unstable West Antarctic Ice Sheet (WAIS). Determining the geological boundary conditions beneath the WAIS and in particular geothermal heat flux may help model its response to external climatic forcing. However, in the Amundsen Sea Embayment sector of WAIS, where major glaciers such as Pine Island and Thwaites are rapidly changing today, fundamental properties such as geothermal heat flux to the base of the ice sheet have remained poorly constrained due to sparse geophysical data coverage and the lack of drilling sites. New crustal thickness estimates derived from airborne gravity data (Jordan et al., 2010, GSA Bul.), are interpreted to show a continuation of the WARS beneath Pine Island Glacier, and suggest two phases of continental rifting affected this region. Here we explore the impact of continental rifting on geothermal heat flux variations and basal water availability beneath Pine Island Glacier. Using 1D thermal models of rift evolution, we assess geothermal heat flux configurations resulting from either single or two-phase rifting and explore the dependency on the age of rifting and pre-rift setting. Additionally, 1D glaciological models were implemented to predict the changes in subglacial water distribution created by different rifting models. Our modelling reveals that geothermal heat-flux beneath the WAIS is critically sensitive to rift age and evolution and has the potential to significantly alter basal conditions if it continued to be active in the Neogene as some recent geological interpretations suggest.