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# Geothermal Heat Flux: Linking Deep Earth's Interior and the Dynamics of Large-Scale Ice Sheets

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Regions covered by continental-scale ice sheets have the highest degree of uncertainty in composition and structure of the crust and lithospheric mantle, compounded by the poorest coverage on Earth of direct heat flow measurements. In addition to challenging conditions that make direct measurements and geological survey difficult Greenland and Antarctica are known to be geologically complex. Antarctica in particular is marked by two lithospherically distinct zones. In contrast to young and thin lithosphere of West Antarctica, East Antarctica is a collage of thick Precambrian fragments of Gondwana and earlier supercontinents. However, recent observations and modeling studies have detected large systems of subglacial lakes extending beneath much of the East Antarctic ice sheet base that have been linked to anomalously elevated heat flow. Outcrop samples from the rift margin with Australia (Prydz Bay) have revealed highly radiogenic Cambrian granite intrusives that are implicated in regional increase of crustal heat flux by a factor of two to three compared to the estimated continental background. Taken together, these indicate high variability of heat flow and properties of rocks across Antarctica. Similar conclusions have been made based on direct measurements and observations of the Greenland ice sheet. Airborne ice-penetrating radar and deep ice core projects show very high rates of basal melt for parts of the ice sheet in northern and central Greenland that have been explained by abnormally high heat flux. Archaean in age, the Greenland lithosphere was significantly reworked during the Early Proterozoic. In this region, the interpretation of independent geophysical data is complicated by Proterozoic and Phanerozoic collision zones, compounded by strong thermochemical effects of rifting along the western and eastern continental margins between 80 and 25 million years ago. In addition, high variability of heat flow and thermal lithosphere structure in central Greenland results from the remanent effects of an Early Cenozoic passage of the lithosphere above the Iceland mantle plume that is implicated in strong thermochemical erosion of the lithosphere and significant long-term effects on the present-day subglacial heat flow pattern and thermodynamic state of the Greenland ice sheet. These observations and our modeling results (Petrunin et al., 2013) show that the present-day thermal state of Greenland and Antarctic lithosphere cannot be well understood without taking into account a long-term tectonic history of these regions. The goal of the IceGeoHeat project is to combine existing independent geophysical data and innovative modeling approaches to comprehensively study the evolution and present state of the lithosphere in Greenland and Antarctica, and assess the role of geothermal heat flux in shaping the present-day ice sheet dynamics. This requires multiple collaborations involving experts across a range of disciplines. The project builds on the IceGeoHeat initiative formed in April 2012 and now including researchers from ten countries in the main core (MC) with expertise in numerical modeling and data assessment in geodynamics, geology, geothermics, cryosphere and (paleo-)climate.

Petrunin, A., Rogozhina, I., Vaughan, A. P. M., Kukkonen, I. T., Kaban, M., Koulakov, I., Thomas, M. (2013): Heat flux variations beneath central Greenland's ice due to anomalously thin lithosphere. - Nature Geoscience, 6, 746-750.