The South Australian Heat Flow Anomaly in east Antarctica: hot rocks in a cool place.

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Sub-glacial geothermal heat flow is acknowledged to be a critical, yet poorly constrained, boundary parameter influencing ice sheet behaviour. Geothermal heat flow is the sum of residual heat from the formation of the Earth and the natural heat generated within the Earth from the radiogenic decay of the major heat producing elements (HPEs), U, Th and K.

Estimates of the sub-glacial geothermal heat flow in Antarctica are largely deduced from remotely-sensed low-resolution datasets such as seismic tomography or satellite-based geomagnetics. These methods provide broad regional estimates of geothermal heat flow reflecting variations in the mantle contribution as a function of thickness of a thermally homogeneous crust. These estimates of sub-glacial geothermal heat flow, although widely utilised in ice sheet modelling studies, fail to account for lateral and vertical heterogeneity of heat production within the crust where HPEs are concentrated and that is known to significantly impact regional geothermal heat flow values.

Significant variations in regional geothermal heat flow due to heterogeneous crustal distribution of HPEs have been recognised within southern Australia, a region that was connected to east Antarctica along the George V, Adélie and Wilkes Lands coastline prior to breakup of Gondwana. The South Australian Heat Flow Anomaly (SAHFA) is characterized by surface heat flows as high as 126 mWm^{-2}, some 2-3 times that of typical continental values, due to local enrichment of HPEs. The SAHFA forms part of a continental block called the Mawson Continent, a now dismembered crustal block that is known, from geological and geophysical evidence, to extend deep into the sub-glacial interior of the Antarctic. It is highly probable that the high geothermal heat flow characteristics of the SAHFA also extend into the sub-glacial hinterland of Terra Adélie and George V lands, a possibility that has not been previously considered in ice sheet studies. In order to account for the occurrence of several sub-glacial lakes in Adélie Land, Siegert & Dowdeswell (1996) concluded that 'a further 25-50 mWm^{-2} of equivalent geothermal heat' was required over the assumed local geothermal heat flow of ca. 54 mWm^{-2}. Although that study concluded that the additional heat required for basal melting was derived from internal ice deformation, they acknowledged the possible role of variations in geothermal heat flow. Now that the SAHFA is well-characterised, this possibility appears very likely.

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References

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