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Newly discovered geothermal anomaly at South Pole ice divide; origins and implications

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Geothermal heat flux directly links geological and cryosphere processes. Understanding Antarctic geothermal heat flux therefore sheds light both on the geological evolution of the continent and on the dynamics of the overlying ice sheet. Recently geophysical techniques and studies of lithology from exposures and glacial erratics have allowed regional assessment of subglacial heat flux and associated geology. However, the blanketing ice sheet means that direct measurements of geothermal heat flux and understanding of the sub-ice geology in the continental interior remain scarce. The South Pole region in particular is one of least understood frontiers in the entire East Antarctic craton due to the paucity of geophysical exploration prior to the recent ESA PolarGAP project.

Here we present new estimates of geothermal heat flux from the ice divide close to South Pole using new PolarGAP airborne radar data. Internal ice sheet layers converging with the ice sheet bed indicate a region of enhanced basal melting $\sim$100 km long and 50 km wide. Models show that locally geothermal heat flux of 120 $\pm$20 mWm-2 is required to account for the observed melting, more than double previous regional estimates for this part of East Antarctica. The geothermal anomaly lies $\sim$500 km inboard from the Transantarctic Mountains, adjacent to a continuation of the Recovery Subglacial Highlands, which appear to truncate the Pensacola Pole Subglacial Basin. We discuss the possible origins of this significant geothermal anomaly, including high heat production lithologies, hydrothermal circulation through faults, or possible Cenozoic volcanism driven by delamination of a lithospheric root. We suggest that high heat production lithologies such as Proterozoic granitoids, coupled with faulting is the most likely cause, consistent with published high heat production values for some glacial erratics and the observed subglacial topography. We further speculate that the geothermal anomaly we observe lies on an ancient tectonic boundary marked by the Recovery Subglacial highlands, which may have been re-activated by later tectonic processes.

Our results highlight the use of aerogeophysical data to resolve Antarctic geothermal heat flux and the underlying complex geological structures in the interior of East Antarctica. In the South Pole region our results are significant for planning future drilling efforts to help constrain subglacial geology and drill the oldest ice. However, further detailed geophysical surveys are required to resolve the geological context of the observed geothermal anomaly.