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Implications for the crustal Architecture in West Antarctica revealed by the means of depth-to-the-bottom of the magnetic source (DBMS) mapping and 3D FEM geothermal heat flux models

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The West Antarctic Rift System (WARS) is one of the largest rift systems in the world, which displays unique coupled relationships between tectonic processes and ice sheet dynamics. Palaeo-ice streams have eroded troughs across the Amundsen Sea Embayment (ASE) that today route warm ocean deep water to the West Antarctic Ice Sheet (WAIS) grounding zone and reinforce dynamic ice sheet thinning. Rift basins, which cut across West Antarctica's landward-sloping shelves, promote ice sheet instability. Young, continental rift systems are regions with significantly elevated geothermal heat flux (GHF), because the transient thermal perturbation to the lithosphere caused by rifting requires ∼100 m.y. to reach long-term thermal equilibrium. The GHF in this region is, especially on small scales, poorly constrained and suspected to be heterogeneous as a reflection of the distribution of tectonic and volcanic activity along the complex branching geometry of the WARS, which reflects its multi-stage history and structural inheritance.

We investigate the crustal architecture and the possible effects of rifting history from the WARS on the ASE ice sheet dynamics, by the use of depth-to-the-bottom of the magnetic source (DBMS) estimates. These are based on airborne-magnetic anomaly data and provide an additional insight into the deeper crustal properties. With the DBMS estimates we reveal spatial changes at the bottom of the igneous crust and the thickness of the magnetic layer, which can be further incorporated into tectonic interpretations. The DBMS also marks an important temperature transition zone of approximately 580°C and therefore serves as a boundary condition for our numerical FEM models in 2D and 3D. On balance, and by comparison to global values, we find average GHF of ∼90 mWm-2 with spatial variations due to crustal heterogeneities and volcanic activities. This estimate is ∼30% more than commonly used in ice sheet models in the ASE region.