Geothermal Heat Flux in East Antarctica from HCA numerical modeling between 60-180°E Longitude

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Estimation of subglacial Geothermal Heat Flux (GHF) is of paramount importance to better understand the dynamics of cryosphere and ice flow of the East Antarctica Ice Sheet (EIAS). Unfortunately, the GHF of East Antarctica is still poorly known and constrained, and direct measurements are still challenging. The EIAS is underlain by major subglacial mountain ranges and basins resulting from distinct geodynamic domains. These include Northern Victoria Land-Ross Sea, the Transantarctic Mountains, the Wilkes Subglacial Basin, the Gamburtsev Subglacial Mountains, the East Antarctic System and a major transpressional fault zone in between (e.g. Cianfarra & Maggi, 2017), which hosts clusters of subglacial lakes. The distribution of sedimentary basins and tectonic structures may affect the GHF in that it exhibits strong regional variations as testified by the presence of subglacial lakes at bedrock topographic elevation/depth with a range exceeding 1500 m, from deep subglacial basins to the flanking highlands. In the framework of the G-IDEA (Geo Ice Dynamics of East Antarctica) project, heat flow from the basement is quantified in key areas of East Antarctica between 60°E and 180°E, by an innovative application of the HCA (Hybrid Cellular Automata) method: the description of stationary conditions of the temperature field is used to replicate the observed distribution of wet vs dry ice-rock contacts in an ice-flowing environment. Evaluation of the geothermal flux is performed in key areas based on the numeric modeling of the ice-rock interaction, which can replicate the spatial distribution of wet contacts and subglacial lakes and is related to local dynamics of the ice sheet and its interaction with the atmosphere. The model takes into account the spatial distribution of the Curie temperature depth as derived from literature. The heat flux is estimated by modeling the stationary state of the ice-rock system with the HCA numerical method, and by its discretization into a large number of cells. Each cell is characterized by physical parameters such as density, enthalpy, thermal capacity and conductivity. By their interaction it is possible to compute their temperature evolution and to replicate the heat diffusion by conduction and convection (the ice movement) in the interfaces ice-rock and ice-atmosphere. The final resolution of the model is about 100 m. The presence of possible anomalous heat flow in the bedrock are identified by a stochastic approach that allow the estimation of the error in the computed heat flow values.