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A New Global Heat Flow Map: An Extrapolation Based on a Multi-Observables Similarity Function

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Since the international heat flow commission published their world heat flow map in 1993, limited attempts have been undertaken to update it and ameliorate a global heat flow prediction. For oceanic crust, the plate-cooling model has been successfully applied to predict the large-scale measured heat flow variations at oceanic crust ages older than 37 Ma, but at younger ages its validity is disputed and heat flow average varies widely. For continents and continental margins, global averages have been more consistent, but the relation with thermo-tectonic age appears inadequate to predict the heat flow variability in many areas. An alternative approach of Shapiro and Ritzwoller (2004) using a global tomographic model to guide the extrapolation of the surface heat flux, resulted in a smooth global heat flow map that depicted for the first a particular uneven heat flow distribution for Antarctica.

We developed a similar method of heat flow extrapolation, incorporating a large set of relevant geological and geophysical features and derivates (tectonic provinces, crustal structure, volcanism, heat production, etc.) which are used to build up heat flow probability distributions for blank heat flow nodes. The method is based on an updated world heat flow database that consists of almost 35000 stations and that covers 20.0% of the earth in a 1˚x1˚ grid. Conform previous estimates based on measured heat flow, we attain a global heat loss of 31 TW and an average heat flow of 61 mW/m^2 (nearly equal for oceans and continents). The resulting heat flow map depicts the main global trends at cratons, orogens and margins, but also shows, in for example Antarctica, northern Africa and South America, more heat flow variability than previously assumed. We performed blind tests by setting aside part of the heat flow data, which showed that the method and selected observables correctly account for the large scale trends of heat flow. The scale difference between global features and heat flow measurements explain the remaining biases. The similarity method may be extended to past times offering the perspective of paleo heat flow estimates.