Gravity and geoid anomalies have already been integrated in many mobile and stationary modeling strategies, and show a satisfactory resolving power for investigating the nature of lithospheric inhomogeneities [2]. Satellite-sourced gravity data alone—which has an unmatched global sampling capability—can also provide estimates independently from other geophysical data, before integration. A relationship between the lithospheric mass distribution (inverted from density contrasts) and models of its thermal state must rely on laws connecting density and thermal parameters. (i.e., radiative heat production, thermal conductivity, boundary conditions), and a set of hypotheses on the heat transport mechanisms involved.

A key factor is the radioactive heat production (RHP) occurring in the crystalline crustal continuum, which exhibits a roll-up against sub-crustal mantle content in U, Th, and K (3) and is a major component of the surface heat flow even when superimposed with concerning near-surface disturbances (4).

While 3D vertical heat transport is expected as a first order mechanism (the steepest gradient in the lithosphere is always the one from LAB to surface), horizontal heat flow arises from horizontal discontinuities in seismic radiogenic heat production, in thermal conductivity and in variation of the boundary conditions (i.e., the thermal thickness of the lithosphere).

With the aim of obtaining reliable results from joint heat flow-gravity field modeling, such as the isolation of the crustal component from surface measurements, or the inversion of thicknesses (e.g., basins) that can recover the regional thermal regime, we show how horizontal heat transport complements the interpretation of surface heat flow, even before taking into account the complex variability of thermal parameters.

An aspect of particular interest is how the relationship between crustal thickness and bulk heat production is affected by this. We identify the straightforward application of gravimetric graphs to obtain thermal thicknesses. This requires the setup of a simple and efficient solver for the heat equation on 3D volumes, adequate for the problems under enquiry and further developments.

**REFERENCES**


**CONCLUSIONS AND OUTLOOK**

1. By interpreting those fits as slope of average heat production (4), intercept = basal flow heat (Q_b) we get:
   - a: increase in crustal heat production is partially compensated by a decrease in Q_b,
   - c: retrieving the heat parameters by fitting different crustal thicknesses underestimate A and overestimate C, the same scaling relationship occurring in (4) both the true surface heat flow and the one retrieved from the gravity anomaly are shown.

2. The same LAB depth results in different Q_b correct strong control by crust and shallow structures.

3. Sensitivity analysis: we must evaluate how structures of regional thermal significance can be sensed. What are the instrumental requirements?

4. The difference between the inverted surface heat flow (blue) from the true one (red) is due to the spatial correlation of gravity, (loss of higher frequencies) and the re-mapping of a multilayer structure to a 2-layer crust-mantle model.

**4 REVISITING THE LINEAR RELATIONSHIP**

In the example of figure 4 the depth-wise distribution of heat production in the reference crust was known. We also knew that it perfectly scaled with crustal thickness (an ideal case: e.g. thickening and thinning of two identical crusts). What is the ideal case of an ideal coverage of surface heat flow measurements, free from any near-surface noise, we try to construct a linear relationship from crustal thickness and surface heat flow?

This equals to the traditional linear model (see 6)

$Q_b = A + B \times \text{thickness}$

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