Brazilian Curie Isotherm – THERMOMAG (Thermo-lithospheric Model)

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Abstract

The variation in temperature and pressure deep within the Earth's lithosphere directly affects a wide variety of rock properties and physical processes. Performing a correlation of crustal thermal modeling from the analysis of the deep temperature can bring valued insights about the variation of temperatures at depth and magnetic petrology. In this work, we present a THERMOMAG thermos-lithospheric model, which is a method of geothermal investigation in the magnetizable crust, thus delimiting the Curie isotherm.

Two geothermal parameters related to the rock interfere directly in the 1D crustal thermal modeling, considering the steady state of heat transfer by conduction: the thermal conductivity (λ) and the radiogenic heat production rate (A) in the crustal layers. Considering a variation rate in these two parameters, the geothermal model of crustal temperature distribution becomes more significant in the geothermal gradient analysis.

The use of Curie depth from the spectral analysis of anomalous magnetic field data, considering the bottom of layers from deeper sources, as being the magnetic boundary of the crust, can to complementary the analysis of the crustal thermal distribution in a indirect way. Basing in the inclinations of the amplitude spectrum (fitting straight lines) and in the use of the combined filtering technique to verify the results of the spectral depth calculations and thus minimize errors.

Thus, the THERMOMAG thermos-lithospheric model is based on a cross-checking of geothermal and magnetometric Curie depth results. This check is carried out in each analysis cell, considering its geotectonic context. A thermomagnetic correction factor (β) is introduced for an improved approximation of the Curie isotherm depth results obtained indirectly. Thus (β) is adjusted for different geotectonic contexts, taking into account the geostructural provinces to which they were related. Therefore, the Curie isotherm data, corresponding to magnetite (Fe_3O_4 - 580^0C), which can be related to the magnetic basement in the lower crust can be determined by:

$$z_{580} = z_M + \beta \tag{1}$$

calculated at the center of the analysis windows, z_{580} corresponds to the thermomagnetically corrected Curie isotherm value of the magnetite, z_m is the Curie depth of the magnetite acquired through the spectral analysis of the aeromagnetometric data and (β) the thermomagnetic correction factor acquired through the cross- check of direct measurements of crustal temperature.

In this first application, we used 2x2 degree cells for the entire Brazilian territory, dividing the interpretations by geotectonic contexts, so the average value of the Brazilian Curie Isotherm (BCI) using the THERMOMAG model was 23km for the provinces Guianas shield, Parana, Borborema and Mantiqueira. The Central Brazil shield presented 22km to the Curie depth, Parnaiba 26km, Tocantins (E) 24km and Tocantins (W) 17km. The São Francisco craton was the province with the greatest average Curie depth, the 38km. Future perspectives aim to improve the windowing in the spectral analysis of magnetometric data for the calculation of subsurface layers and to improve the script of this model encompassing the thermomagnetic correction factor adjusted to each geological context by new acquisitions of direct temperature data.