

Interactive comment on “Constraining the geotherm beneath the British Isles from Bayesian inversion of Curie depth: Integrated modelling of magnetic, geothermal and seismic data” by Ben Mather and Javier Fulla

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We would like to thank the reviewer for the constructive comments and suggestions. Please find a point-by-point response to each of the issues you have raised in your review.

(1) Deeper Curie depths have higher uncertainty and therefore it is unclear how reliable the results of the Curie depths in southwest Ireland are. There is a discussion on the effect of increasing window sizes, but does this mean these results should be

C1

discounted due to the large error?

The reviewer has highlighted an important observation that the uncertainty of Curie depth increases substantially with depth. Based on our results, we find that the method of Curie depth calculation (explained in the methods section) is generally only suitable to quantitatively resolve relatively shallow magnetic layers. The presence of deep Curie Depths should be regarded as a quantitative feature from the inversion, i.e. a likely cold lithospheric region where the amplitude (temperature in our case) is not well resolved. Whether the highly uncertain results in SW Ireland should be discounted is up to interpretation and is something that, in any case, would require considering additional independent data sets. The latter would be out of the scope of the present paper where we rather focus on the degree of uncertainty associated with Curie depth estimates, in line with the topic of the special issue “Understanding the unknowns: the impact of uncertainty in the geosciences”.

(2) Similarly very deep Curie depths are shown in the southern North Sea. I have assumed this is an error due to a lack of magnetic anomalies.

This is a good point. Our Curie depth estimations use the EMAG2 magnetic anomaly, which splices multiple regional grids and satellite data. The effective resolution of these data vary spatially. On the matter of spatial resolution of EMAG2 we add “It is important to note that the effective resolution of this global compilation is inherited from multiple regional grids and satellite data that are spliced together to form the EMAG2 dataset.” On the matter of uncertainty we add “Higher uncertainty in the southern North Sea is compounded by the lack of magnetic data and thus very large window sizes in order to capture any sensitivity to the magnetic thickness.”

(3) There is a lack of surface heat flow measurements to corroborate the simulated heat flow, but some are shown for the tip of northeast Scotland. These measured data are less than the simulated heat flow data. Does this imply that the simulated heat flow is too high? If not, why do the data disagree?

C2

The misfit between the simulated heat flow data and measured data are 5-10mW/m² in northeast Scotland. These differences could be attributed to local effects perturbing the regional geotherm. We find that this is quite low compared to the large misfits observed within granitic batholiths (indicated by white circles overlain on the heat flow map – Figure 9a) because of substantial upper crustal enrichment in heat-producing elements. To clarify our position on this matter we have added the following text to the discussion section of the manuscript, “In general, Curie depth estimates are sensitive to the regional heat flow regime and cannot resolve anomalies that locally alter surface heat flow. These effects include granitic intrusions and hydrothermal advection among others. In spite of this, the misfit between simulated heat flow and data do not exceed one standard deviation of all thermal models in the ensemble (Figure 9b). In locations of high misfit, assimilating alternate geophysical sources, such as seismic data (i.e. refraction, surface waves, or receiver functions), may offer better constraints on geothermal heat flow.” On the matter of the spatial distribution of heat flow data, we add “Heat flow data is clustered mainly within coastlines and in some localised areas offshore.” We outline the misfit between data and observations as follows:

(4) The measured heat flow are from Pollack et al. (1993) which is an abstract. As the data cannot be referenced they should be included in the paper and compared to the simulated data.

Thank you to the reviewer for bringing this to our attention. The custodians of these data seems to be replaced regularly. The most recent location is this website: <https://engineering.und.edu/research/global-heat-flow-database/data.html> which we embed within within the original reference for Pollack et al 1993.

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2019-9>, 2019.