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Estimating the Curie point depth using aeromagnetic data with a fractal model in the Province of Québec, eastern Canada

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New technologies that allow geothermal energy production in colder conditions result in interest for geothermal exploration in low heat flux regions that were previously overlooked. The Province of Québec, eastern Canada, is such a case. It is a large and cold area with a low amount of heat flux measurements, and mapping the Curie point depth is appealing as an exploration tool due to the scarcity of the direct data. For that purpose, we have revisited a methodology to estimate the Curie point depth using a fractal source distribution model and aeromagnetic data. Our methodology relies on a statistical model of crustal magnetization having a constant magnetization direction and random magnetization amplitude. The shape of the radial average of the logarithm of the power spectrum of magnetic anomalies is predicted using this model. The model parameters (thickness and depth to the top of the magnetic layer, the fractal exponent β and the constant C') are obtained by calculating the best fit between the theoretical and observed radial power spectra using a non-linear least-square algorithm. Rather than using a constant value for the fractal exponent β over the whole study area, which would overcorrect the shape of the radially averaged power spectra in some zones, we propose a new calibration workflow based on heat flux measurements and lithology. This workflow includes the use of sequential Gaussian simulations (SGS) of heat flux data to enlarge the limited available dataset. The use of SGS also allows quantifying the uncertainty and the range of the predicted Curie point depths. This work contributes to mapping the Curie point depth at large scale and help identifying potential areas for further detailed exploration programs and potential geothermal energy production in the Province of Québec.