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Influence of calculation error of total field anomaly in strongly magnetic environments

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An assumption made in many magnetic interpretation techniques is that ΔT_{act} (total field anomaly — the measurement given by total field magnetometers, after we remove the main geomagnetic field, T_0) can be approximated mathematically by ΔT_{pro} (the projection of anomalous field vector in the direction of the earth's normal field). In order to meet the demand for high-precision processing of magnetic prospecting, the approximate error E between ΔT_{act} and ΔT_{pro} is studied in this research. Generally speaking, the error E is extremely small when anomalies not greater than about $0.2T_0$. However, the error$E$ may be large in highly magnetic environments. This leads to significant effects on subsequent quantitative inference. Therefore, we investigate the error E through numerical experiments of high-susceptibility bodies.

A systematic error analysis was made by using a 2-D elliptic cylinder model. Error analysis show that the magnitude of ΔT_{act} is usually larger than that of ΔT_{pro}. This imply that a theoretical anomaly computed without accounting for the error E overestimate the anomaly associated with the body. It is demonstrated through numerical experiments that the error E is obvious and should not be ignored. It is also shown that the curves of ΔT_{pro} and the error E had a certain symmetry when the directions of magnetization and geomagnetic field changed. To be more specific, the E_{max} (the maximum of the error E) appeared above the center of the magnetic body when the magnetic parameters are determined. Some other characteristics about the error $E$are discovered. For instance, the curve of E_{max} with respect to the latitude was symmetrical on both sides of magnetic equator, and the extremum of the E_{max} can always be found in the mid-latitudes, and so on. It is also demonstrated that the error Ehas great influence on magnetic processing transformation and inversion results.

It is conclude that when the bodies have highly magnetic susceptibilities, the error E can be great and affect the subsequent magnetic processing and inversion. Therefore, the error cannot be ignored when processing, inverting, and interpreting magnetic data in highly magnetic environments.