New analytic formulae of magnetic anomalies for a homogeneous polyhedral body

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Developing a high-precision forwarding modeling algorithm for the geomagnetic field of the Earth is an important issue in geophysics, which is considered as one of the basic tools to detect the deep structure of the Earth. During the last 20 years, more and more attention has been paid on deriving closed-form solutions for magnetic anomalies caused by a single body, for instance, a rectangular prism and a polyhedral body, which can be adopted to accurately evaluate magnetic potential, magnetic field, as well as the magnetic gradient tensor. Due to its capability of approximating complicated underground geological bodies, a general polyhedral body is prefered. In this paper, we present new analytic formulae of magnetic potential, magnetic field and magnetic gradient tensor for a 3D polyhedral body with a homogeneous magnetization vector. First, a local right-handed coordinate system was established with the observation site being the origin. Then, divergence theorems and gradient theorems are invoked to transform the volume integral into surface integrals. By deriving the closed-form solutions for these surface integrals, we finally obtained the exact solutions for magnetic anomalies for the polyhedal body. Two synthetic models are adopted to verify the accuracy of our newly derived analytic formulae by comparing with other analytic and numerical solutions. Excellent agreement is obtained between these different methods, which implies that our presented approach can be safely applied to calculate a magnetic field and its gradient tensor with high precisions.