3D MAGNETIC MODELLING FOR ELLIPSOIDS

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Abstract.

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1 Introduction

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2 Methodology

2.1 Geometrical aspects

Let (x, y, z) be a point referred to a Cartesian coordinate system with axes x, y and z pointing to, respectively, North, East and down.

Consider an ellipsoidal body with centre at the point (x_c, y_c, z_c), semi-axes defined by positive constants a, b, c, and orientation defined by three angles α, β, and γ.

The points (x, y, z) located on the surface of this ellipsoidal body satisfy the following equation:

$$(\mathbf{r} - \mathbf{r}_c)^T \mathbf{A} (\mathbf{r} - \mathbf{r}_c) = 1 \, , \tag{1}$$

where $\mathbf{r} = [\begin{array}{ccc} x & y & z \end{array}]^\top$, $\mathbf{r}_c = [\begin{array}{ccc} x_c & y_c & z_c \end{array}]^\top$, $\mathbf{A}$ is a positive definite matrix given by

$$\mathbf{A} = \mathbf{V} \begin{bmatrix} a^{-2} & 0 & 0 \\ 0 & b^{-2} & 0 \\ 0 & 0 & c^{-2} \end{bmatrix} \mathbf{V}^\top \, , \tag{2}$$

and $\mathbf{V}$ is an orthogonal matrix whose columns are defined by unit vectors $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$.

The vectors $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$ have the same direction as the semi-axes a, b, c of the ellipsoid, depend on the orientation angles α, β, γ and are defined according to the ellipsoid type.

For triaxial ellipsoids (i.e., $a > b > c$), the vectors $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$ are given by (**?**):

$$\mathbf{v}_1 = \begin{bmatrix} -\cos\alpha \, \cos\delta \\ -\sin\alpha \, \cos\delta \\ -\sin\delta \end{bmatrix} , \tag{3}$$

$$\mathbf{v}_2 = \begin{bmatrix} \cos\alpha\, \cos\gamma\, \sin\delta + \sin\alpha\, \sin\gamma \\ \sin\alpha\, \cos\gamma\, \sin\delta - \cos\alpha\, \sin\gamma \\ -\cos\gamma\, \cos\delta \end{bmatrix}, \tag{4}$$

$$\mathbf{v}_3 = \begin{bmatrix} \sin\alpha\, \cos\gamma - \cos\alpha\, \sin\gamma\, \sin\delta \\ -\cos\alpha\, \cos\gamma - \sin\alpha\, \sin\gamma\, \sin\delta \\ \sin\gamma\, \cos\delta \end{bmatrix}. \tag{5}$$

Similarly, the vectors $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$ defining the semi-axes of prolate ellipsoids (i.e., $a > b = c$) are calculated by using equations 3, 4, and 5, but with $\gamma = 0°$ (**?**).

Finally, the vectors $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$ defining the semi-axes of oblate ellipsoids (i.e., $a < b = c$) are

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3 Conclusions

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Appendix A

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Author contributions. TEXT

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References

Clark, D., Saul, S., and Emerson, D.: Magnetic and gravity anomalies of a triaxial ellipsoid, Exploration Geophysics, 17, 189–200, 1986.

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