Shape and distribution anisotropy of irregular arrangements of diverse bodies – a 3D computational model

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The magnetic fabric of strongly magnetic materials originates from (1) self-demagnetization in bodies of non-isometric geometry, and (2) magnetostatic interactions between bodies with non-random distribution. These contributions, termed shape anisotropy and distribution anisotropy, carry information about a rock’s formation or deformation history. Both may be important when magnetite grains control the anisotropy of a rock, or when the pore space of a rock is impregnated with strongly magnetic fluid. The relative importance of each contribution to the overall anisotropy is debated, partly because it is influenced by many factors, including the body shape, orientation, or spacing. Another challenge is that existing models of distribution anisotropy consider infinite regular arrangements of equal bodies and take into account nearest neighbour interactions only. These simplifications make it difficult to predict distribution anisotropy in real rocks, where particles or pores are distributed irregularly, and display a range of sizes, shapes and orientations. A new model is presented here, which calculates both shape and distribution anisotropy for irregular assemblages of diverse bodies – differing in their size, shape, and orientation. The model assumes ellipsoidal bodies of equal intrinsic magnetic susceptibility in a non-magnetic matrix. Input parameters include the coordinates of each body centre, dimensions and orientation vectors of the three principal axes. These can be derived from imaging and X-ray computed tomography, or be pre-defined parameters of man-made samples. Calculations were verified against magnetic pore fabric measurements performed on synthetic samples with known pore parameters. The model is expected to advance our understanding of the interplay between shape and distribution anisotropies in natural samples. Hence, it will facilitate structural interpretations in samples whose magnetic fabrics are predominantly controlled by magnetite, as well as the interpretation of magnetic pore fabrics in future studies.