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3D Bayesian inversion of magnetic data applied to Basse-Terre volcanic island, Guadeloupe, Lesser Antilles

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We linearly invert magnetic data for 3D magnetization distribution using a Bayesian methodology with a grid discretization of the space. The Bayesian approach introduces covariance matrices to regularize the ill-posed problem and overcome the non-uniqueness of the solution (Tarantola & Valette, 1982). The use of spatial covariance matrices and grid discretization leads to smooth and compact models. The algorithm provides 3D magnetization models along with resolution parameters extracted from the resolution matrix. The direct computation of the magnetic field includes the surface topography and assumes a linear relationship between rock magnetization and the magnetic field they produce.

The methodology is applied to aeromagnetic data from the volcanic island of Basse-Terre in Guadeloupe, Lesser Antilles (Le Borgne & Le Mouël 1976, Le Mouël et al., 1979). Low magnetizations (a few A/m) allow linear inversion that takes into account polarity inversions of the geomagnetic field that occurred across the volcanic history of the island. Inverted magnetizations are consistent with paleomagnetic measurements on surface samples (Carlut et al., 2000 ; Samper et al., 2007). The resulting 3D model is validated against a 2D inversion performed in the Fourier domain (Parker & Huestis, 1974; Bouligand et al., 2014). The 3D distribution of magnetization helps identifying the different volcanic edifices that build the island both at the surface and up to 3 km depth.