Synthetic three-dimensional finite-element electromagnetic modelling study of Nishinoshima magma chamber.

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Most of the currently used electromagnetic (EM) modelling and inversion codes approximate earth subsurface with rectilinear structured meshes. This is not optimal, especially in a marine environment, as a large portion of the computationally feasible grid is used up by bathymetry, at the same time reducing the resolution of the upper region. We implement an efficient, flexible and robust EM modelling code, that is based on finite-element (FE) methods with adaptive unstructured meshes and allows accurate approximation of complex model geometries. Finite-element modelling approaches only recently started to become popular in the EM community. At the same time, FE methods have been used extensively in other fields, in particular in solid mechanics and fluid dynamics, and are the focus of active mathematical research. We transfer the FE experience gained in other fields to geophysics. Our code uses the open source FE library *deal.II*. This library is based on fully unstructured hexahedral meshes which typically require 4-10 times fewer elements than tetrahedral meshes to obtain the same rate of convergence. In addition, *deal.II* allows for a high level of parallelization and scales to several thousand processors.

We show first results of the application of the code for imaging the newly developed volcanic island Nishinoshima. Imaging of Nishinoshima's magma chamber will help to understand the processes that are involved in the development of new continental crust. Nishinoshima is located in an area with complex sea-floor bathymetry which has to be properly incorporated into resistivity models in order to obtain accurate EM responses, as otherwise the responses on the slopes of the bathymetry can differ by orders of magnitude.

In the future, and outside of the scope of this work, we will employ the newly-developed FE forward code as an engine for an inversion. We plan to invert the data acquired at the Nishinoshima island that were retrieved from the sea-floor end of May this year, to image the magma chamber.