Development of an inversion of the anisotropic electrical conductivity model

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We developed a prototype of an inversion code for obtaining three-dimensional (3-D) fully anisotropic electrical conductivity model, because there is no tool to directly invert observed electromagnetic (EM) data to fully anisotropic model. The anisotropy of the structure is very important parameter to elucidate the structure, chemical composition and dynamics, especially the electrical anisotropy can be very strong under hydrated circumstances and can be detected by the MT surveys (e.g. Baba et al., submitted).

On the development of the inversion code, we used the modified IDM (MIDM; Singer, 1995) to solve forward problems of the EM induction, which is one of the integral equation methods used for (isotropic) 3-D EM modeling studies. The MIDM is suitable to develop the anisotropic inversion code, because only small modifications are needed for incorporating the arbitrary anisotropy. For solving inverse problems, we use non-linear inversions of least square minimization method by using the quasi-Newton method which was developed for 3-D isotropic electrical conductivity structure by Koyama (2001).

For model parameters of the inversion, logarithmic values of the electrical conductivity in each model grid have been used in conventional studies, because the electrical conductivity is positive and varies drastically by the order with temperature, chemical component and so on. However, this is not the case for full anisotropic conductivity because the conductivity is defined as a 3x3 tensor and all the components may not be positive. Then, we applied the singular value decomposition to the conductivity tensor. By using the fact that the Joule heat must be positive, the electrical conductivity tensor can be expressed as a diagonal matrix with three positive singular values and two rotation matrices. Therefore three logarithmic values of positive singular conductivities, and six angles for two rotation matrices are used for nine parameters of the tensor.

In this presentation, we show the results of simple synthetic examples of the anisotropic inversion.