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Distinguishing structural and anisotropy strikes using magnetotelluric phase and amplitude tensors

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Estimating a geoelectric strike direction is a common procedure in magnetotelluric data analysis. Nowadays the phase tensor (Caldwell et al. 2004) is widely used, usually assuming isotropic media. If we take account of anisotropic media, however, two types of strike directions are involved: 2D structural strikes and anisotropic strikes. Distinguishing them is necessary to properly interpret the geoelectric structures.

In this presentation, we additionally use the amplitude tensor recently introduced by Neukirch et al. (2016: poster in EGU) to estimate geoelectric strikes. We see that the phase tensor detects structural strikes while the amplitude tensor detects the anisotropy strikes, so combining them enables us to estimate the two directions separately.

First, basic properties of the amplitude tensor are examined in simple structures. Analytic expressions for isotropic 1D and 2D media indicate that it resembles not the phase tensor but the impedance tensor in form. It implies that the WAL-type criterion (Weaver et al. 2000) is appropriate to estimate directionality. We use the impedance expansion formula for 1D anisotropic media (Okazaki et al. 2016) to show that the amplitude tensor detects the azimuth of maximum conductance at long periods, which suggests its effectiveness as a directionality tool for anisotropic media.

Then the strike estimation in 2D anisotropic media is presented. The model consists of an anisotropic dyke sandwiched by another anisotropic medium (Reddy and Rankin 1975). The phase tensor typically points the structural strike direction. This is because the phase tensor is insensitive to anisotropy itself; it mostly detects the spatial variation of resistivity (Heise et al. 2006). On the other hand, the amplitude tensor points the anisotropy direction of the medium just under the observation point at shorter periods, and approaches the anisotropy direction of the sandwiching medium as bulk anisotropy at longer periods. This is understood as the amplitude tensor directly reflecting the resistivity of each direction.