Time domain inversion of one-dimensional magnetotelluric data

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SUMMARY

We present a new time domain inversion method for one-dimensional magnetotelluric (MT) data. The MT method is an effective exploration tool that uses surface measurements of the natural magnetic field and induced electric field to determine the subsurface electrical conductivity structure. Most MT data are analysed and processed in the frequency domain; very little research has been conducted on time-domain analysis of MT data. The curl of the electric field is equal to the time-derivative of the magnetic field. Deconvolution of the measured electric field for the time-derivative of the measured magnetic field yields the response of the electric field to an impulse in the time derivative of the magnetic field. The forward model is derived from the relation between horizontal magnetic field and electric field variations, generating a recursion formula consisting of electromagnetic reflection and transmission coefficients. The time domain inversion is based on a time-domain layer-stripping scheme, operating from the surface downwards, in which the horizontal layer model is discretized into Goupillaud layers of equal vertical travel time. The inversion is stabilised by limiting the amplitude of the smallest reflection coefficient. We use the forward model to reproduce the results of two landmark published papers both in the frequency domain and the time domain, and demonstrate the inversion scheme on synthetic data.