Study on the magnetotelluric strike direction estimate

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The strike direction is an important parameter in magnetotelluric (MT) data processing, and the change of strike with depth may be associated with different structures and processes in the crust and mantle (Marquis et al.,1995). Phase tensor decomposition (Caldwell et al, 2004) and GB decomposition (Groom & Bailey, 1989) are the two most frequently used methods to estimate strike from MT impedance tensor. However, the strike direction estimated from the two methods is unstable in the presence of noise, and Muñíz et al. (2017) proposed a method based on phase tensor decomposition to estimate the stable strike of impedance tensor in the presence of noise under the assumption that the strike is continuous with frequency. We have studied this method and applied a similar strategy to obtain a stable strike.

We used the BC87 data set site lit902 to study the influence of noise on the estimate of strike, we added 2 %, 5 % Gauss white noise to the impedance tensor, the intensity is proportional to the variance of each component for every period, and estimate the strike for 100 times through the GB and CCB methods, we found that the optimal strike direction is close to the true strike, with the assumption that the strike is continuous with frequency, we get a similar strategy to obtain the stable strike like Muñíz et al (2017).1) Add noise to the impedance tensor for m times, the noise intensity is proportional to the variance of each period; 2) Get the strike of each period for m times; 3) Calculate the variance of m strikes for each period. 4) There is a period with the minimum variance, and the strike for that period is the median of m strikes; this strike is used as the seed to select the neighboring strike that produces the smallest slope over period, and then the selected value plays the role of the seed, and so on to the first and last periods; 5) Repeat the steps ahead several times, estimate the mean and standard deviation of the strikes; 6) Optimize the result, prerotate the original impedance for an optimal angle, and recover after the estimate, the prerotation angle is calculated from formula 1-1; The flow chart is shown in Figure 1.

$$\varphi(\theta)=\sqrt{\frac{1}{nt}\sum_{j=1}^{nt}(r_j(\theta)-\theta)^2} \quad \text{1-1}$$

We applied the algorithm to the processing the site lit902 in the BC87 data set, Figure 2a is the strike direction distribution of 100 times Gauss random white noise. Figure 2b is the result of strike, and we can find the intermediate frequency section strike with a low error level. Thus, the strike is trustworthy, and the strike can be used for other related processing.

The estimate of strike direction is strongly influenced by the noise, so we can add a low intensity noise to test the robustness of the strike, by adding noise to impedance several times and then estimate the stable strike direction, we can obtain a more stable and reliable strike direction, with the addition of variance or uncertainty, we can make an appraisal of the estimation result, and obtain the reliability of the strike direction.

This project is financially by the National Natural Science Foundation of China（grants No. 41504061, grants No. 41674078）and the National Key Research and Development Project of China （grant No. 2016YFC0600302）.

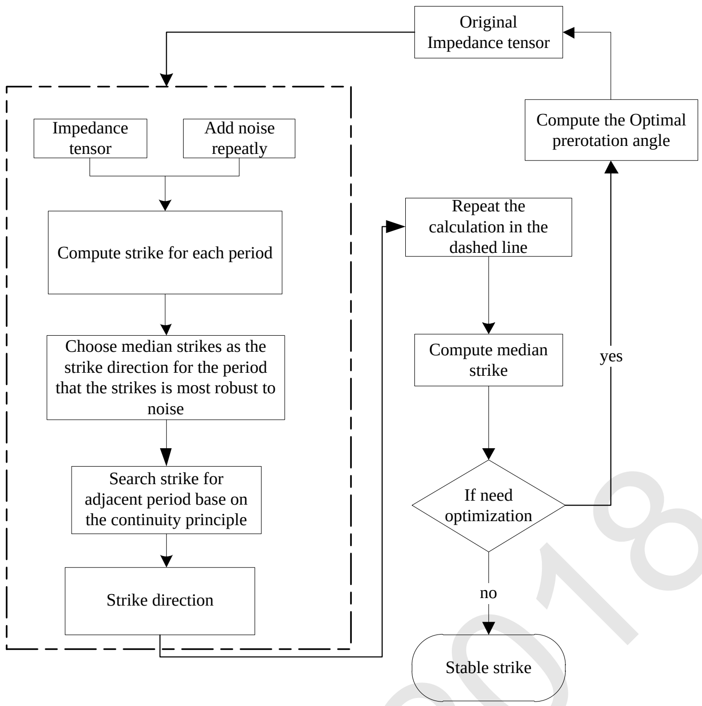
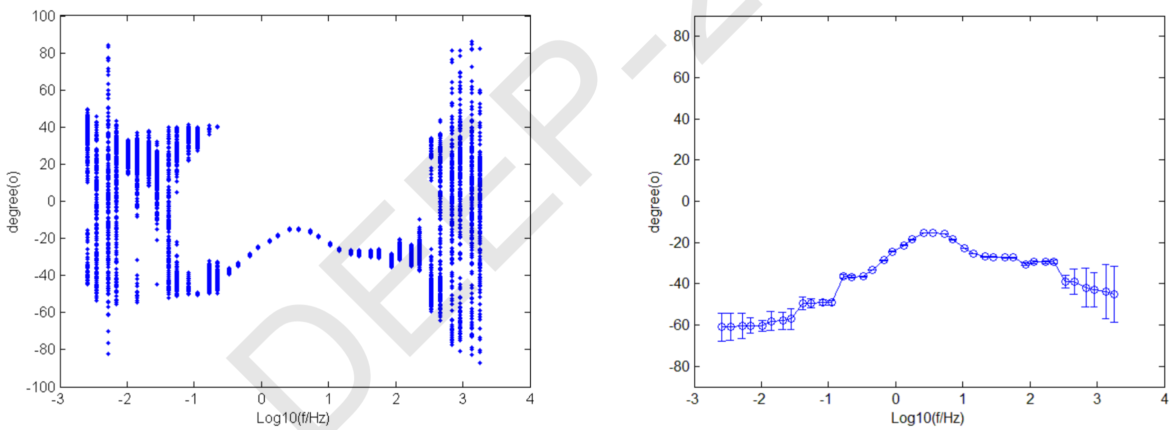


Figure 1. The flow chart of stable strike estimation



a: Strike distribution of 100 times b: The estimated strike

Figure 2. Stable strike estimation of site lit902

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