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2.5-dimensional Single Component Inversion of REBOCC and Computing Advantages Using CSAMT Sounding Data

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Abstract: CSAMT method has the advantages of strong anti-interference ability and high collection efficiency. Since the 1980s, it has been widely used in various geological surveys in China. CSAMT uses a similar definition of the Cagniardresistivity based on the impedance calculation of the MT. The "field source effect" produces a spherical wave effect related to the frequency of the artificial field source. That is, due to the influence of the near zone and the transition zone, the Cagniard resistivity is severely distorted.It is observed as a 45 degrees inclination in low-frequency zone on bi-logarithmic plot of subsurface apparent resistivity. Therefore, CSAMT data processing can only select "far area" data. Using existing processing methods, it is difficult to ensure that the selected CSAMT data of different frequencies can satisfy the "far zone" condition; that is, it is difficult to ensure that the current CSAMT detection results are completely true. Moreover, the artificially emitted electromagnetic field is in the "near zone" and "transition zone", and its spherical wave properties do not satisfy the theoretical basis of the electromagnetic field data processing, Therefore, CSAMT data is largely wasted and decline the detection capability.

Based on the above reasons, this paper uses the electromagnetic field value of the field source to perform the inversion of Cagniardresistivity. The 2.5-dimensional problem is solving the electromagnetic response of a three-dimensional excitation field source on a two-dimensional or approximately two-dimensional structure. In this case, the 2.5-dimensional problem is more effective in inverting the change of the electromagnetic field value than the pure two-dimensional problem, and the calculation amount is reduced compared with the complete three-dimensional problem, which saves the calculation time and meet the need of reality.

The REBOCC inversion method inherits the advantage that the OCCAM inversion method which is less affected by the initial model and the operation convergence is stable (Siripunvaraporn et al., 2000). The method expresses the solution as a linear combination of rows of the sensitivity matrix smoothed by the model covariance. Transforming its linearized inverse problem from the M-dimensional model space to the N-dimensional data space. Since generally N is much smaller than N, it has greatly reduced the computation time and hardware requirements.

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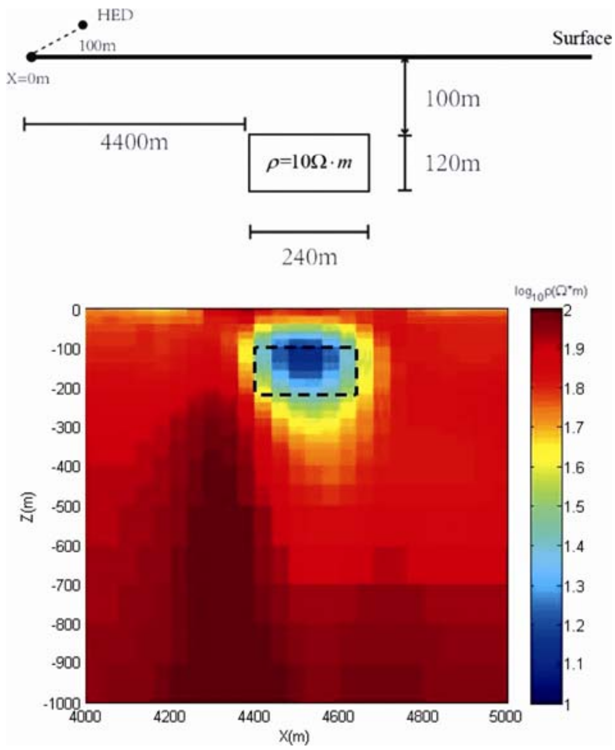

Fig. 1. Theoretical model and inversion results of the Ex component

(a) Theoretical model, The theoretical model resistivity is 10Ω·m, the background resistivity is 100Ω·m, and the source is transmitted by HED and is located 100m in the direction of the vertical line; (b) The acquisition frequency is 1Hz-512Hz, a total of 10 frequency points, the observation point is between X=4000m and X=5000m, and the point distance is set to 40m, totaling 26 observation points. Inversion is performed by adding 5% random noise to the forward model data of the theoretical model. The inversion model was obtained by performing 8 iterations using the subspace p=2, s=0 mode.

In order to objectively explain the calculation and storage advantages of inversion, horizontal comparison is made in the mainstream inversion methods represented by OCCAM, DASOCC, and REBOCC.The main calculations of the above three methods are concentrated on the calculation of the sensitivity matrix, so the calculations of the cross-product matrix and the solution equations are compared, as shown in Table 1. In terms of space storage, the memory space required by the three

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methods is realized by storing the sensitivity matrix and the cross -product matrix, as shown in Table 2.

Table 1 Comparison of calculation times

Method	Cross-product matrices *	Solving equations**	Other calculations *
OCCAM	NM^2	$M^3/6$	-
DASOCC	MN^2	$N^3/6$	-
REBOCC	ML^2	$L^3/6$	L^3
	* Each iteration		** Every searchλ

Table 2 Storage requirements comparison

Method	Cross-product matrices	Sensitivity matrix	Difference matrix
OCCAM	$M^2/2$	NM	-
DASOCC	$N^2/2$	NM	-
REBOCC	$L^2/2$	LM	$N \times L$

Note:As L approaches N, the extra calculations and memory required with the REBOCC method become significant. However, L only needs 10%-30' of N to ensure iterative convergence, so REBOCC can at least reduce memory requirements by at least 60% and CPU time by more than 80% compared to DASOCC.

Using the REBOCC method for inversion, its computational advantage can greatly shorten the calculation time and save computing resources when the inversion effect is basically unchanged. In the actual work, the setting of P and S can reduce unnecessary calculations. The data is very helpful for improving the efficiency of the inversion.

Key words: CSAMT, 2.5-dimensional inversion, REBOCC, single component inversion

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