Synthetic Cole-Cole model of sulphide deposit

Vlad Kaminski[1], Andrea Viezzoli[1]
1. Aarhus Geophysics Aps, Denmark, andrea.viezzoli@aarhusgeo.com

A synthetic model of sulphide deposit was simulated using the program "***AarhusINV***". Figure 1 shows the true model considered for the exercise. Table 1 contains the true model Cole-Cole parameters. The simulation was carried out for a 2015 long-pulse VTEM system.

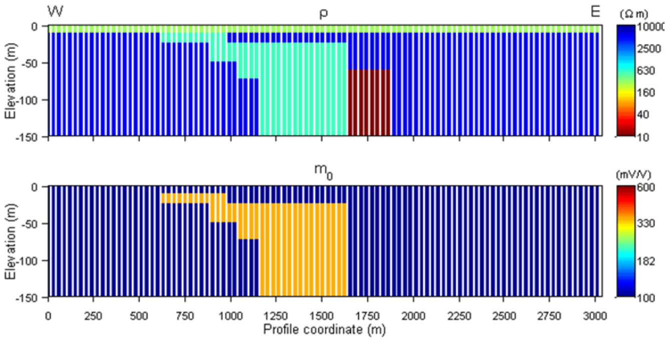

Figure 1. True model of simulated sulphide deposit.

Sulphide	ρ (Ohm m)	m_0 (mV/V)	τ (s)	C (N/A)
Overburden	250	10	0.001	0.5
Disseminated sulphide	500	350	0.001	0.5
Massive sulphide	1	1	0.001	0.5
Host Rock	5000	1	0.001	0.5

Table 1. Cole-Cole parameters considered for the modelling exercise.

The disseminated sulphide is made chargeable and non-conductive, while the massive sulphide is made non-chargeable and conductive. The τ and C parameters were considered constant. The challenge was to recover chargeable material by virtue of IP inversion using "***AarhusINV***" at significant depth on noisy data.

Firstly, an IP-effect measure was introduced, governed by equation (1).

$$(1) \qquad m_{IP} = \frac{\sum_{j=1}^{n_t} log_{10}\|V_{NOIP}^{j} - V_{IP}^{j}\|}{n_t}$$

In this equation $\boldsymbol{m_{IP}}$ is the introduced measure of the IP effect, $\boldsymbol{V_{NOIP}}$ is the recorded voltage without consideration of the Cole-Cole model for the j-th time gate in a transient and $\boldsymbol{V_{IP}}$ is the corresponding voltage with the consideration of the Cole-Cole model at j-th time gate, while $\boldsymbol{n_t}$ is the number of time gates in the transient for which the measure is calculated. Figure 2 shows this measure calculated for the model in Figure 1.

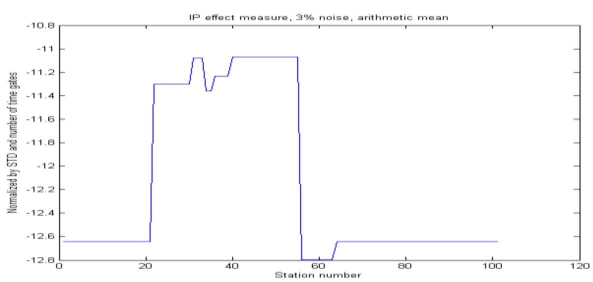

Figure 2. IP effect measure for the synthetic sulphide model.

Then the data were perturbed with noise and synthetic altitude test was performed. Figure 3 shows the transients simulated at station 50 (profile coordinate 1500) at different flight altitudes, ranging from 30 to 100 m.

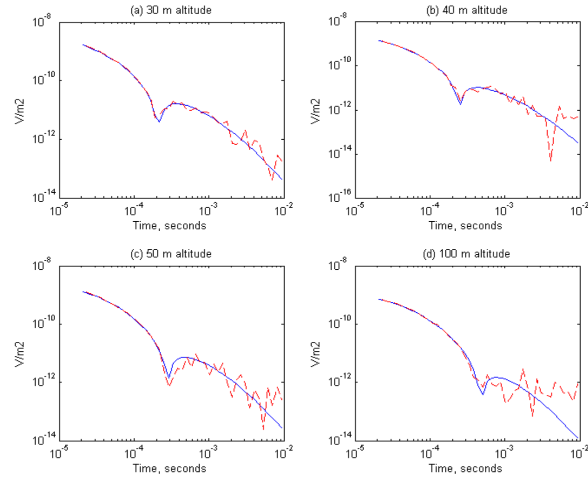

Figure 3. Results of altitude test over synthetic model. Blue: noise-free data (abs. values); red: noise-perturbed data (abs. values).

The noise-perturbed data simulated for 30 m flight altitude were inverted in IP mode using "***AarhusINV***" program and the following Cole-Cole parameters for starting model: ρ = 1000; m_0 = 50, τ = 10^{-4}; C = 0.7 and "soft" constraints on τ and C. This model was refined by adding some a-priori information to run a constrained inversion and thus to improve the recovery of the chargeable target and depths. The results of these inversions and the data misfits are shown in Figure 4 with consideration of depth of investigation.

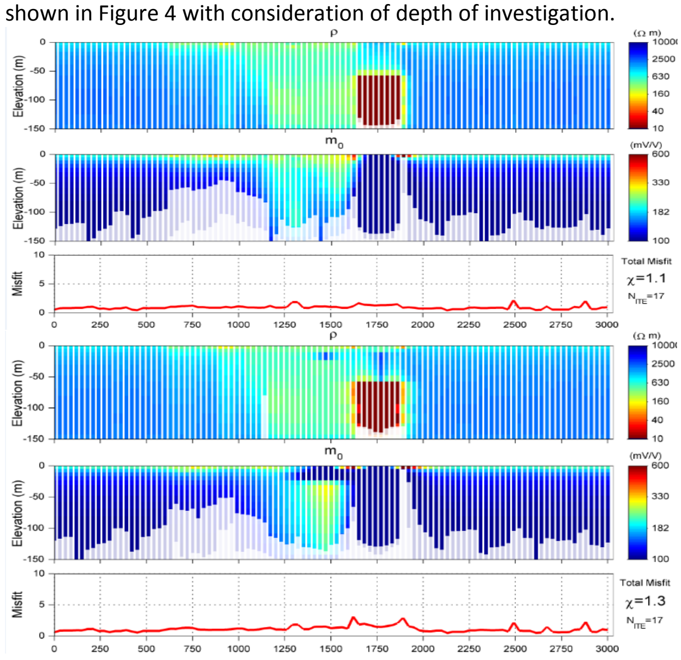

Figure 4. Top: simple inversion; bottom: inversion with a-priori.

Contact information
Telephone: +39.392.297.9326
Email: info@aarhusgeo.com
Website: http://www.aarhusgeo.com