The mineral deposits of Budunhua copper mine based on the Rectifier inverter circuit

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Abstract

In this paper, transient electromagnetic method (TEM) is applied to the interpretation work of Budunhua copper mine. Through the simulation research of the time and frequency characteristics of the secondary magnetic field of established transient electromagnetic field, draw the corresponding curve, and verify the correctness of transient electromagnetic field establishment. Meanwhile, according to the known parameters, calculate electrical parameters of transient electromagnetic field, respectively utilizing the early and late apparent resistivity formula and the all-time apparent resistivity formula, calculate and analyze the apparent resistivity of magnetic field, and draw simulation curve diagram. By analyzing the simulation diagram, concluded that the two methods have the same function in the transient electromagnetic field interpretation work, but the formula of all-time apparent resistivity is more comprehensive and more continuous. Finally, through the analysis and simulation of abnormal magnetic field, obtain the distributed situation of copper mine, and the average grade of the copper ore body is $0.6 * 10^{-2}$**.**

Keywords

Transient electromagnetic method; Budunhua Copper Mine; Rectifier inverter circuit.

1. Introduction

Budunhua is located in Horqin Right Middle Banner of the Inner Mongolia Autonomous Region, at the eastern margin of middle section of Greater Khingan Range and the west side of the Nenjiang River deep fracture, with Lianhua mountain medium-sized copper silver mine, Meng Entao Li Gai large-scale silver lead zinc mine and so on constitute one by the copper primarily polymetallic ore concentration area，has great development value[1-3].

The region shows different stratigraphic composition. Among them, Paleozoic contains sandstone, metamorphic sandstone, mica quartz schist, slate and so on; Mesozoic group contains conglomerate, tuffaceous conglomerate, tuff breccia, tuff, volcano clastic rocks, etc. Cenozoic erathem mainly has alluvial clay, gravel, etc.

2. Analysis of frequency characteristic on transient electromagnetic field

Frequency characteristic of secondary magnetic field refers to the regularity of the imaginary and real component of secondary magnetic field (Or amplitude and phase of secondary magnetic field) relative to primary magnetic field strength changes with frequency.

From formula (5), getting:

$$H_2 = -\frac{MI_1G}{L}\left(\frac{\alpha^2}{1+\alpha^2} + i\frac{\alpha}{1+\alpha^2}\right) \quad (1)$$

$\alpha = \omega L / R$. Parentheses part represents response function of secondary magnetic field which decided by the underground conductor electromagnetic property, so α can be called response parameter.

According to the known parameters, program in MATLAB, the secondary magnetic field response curve as shown in Figure 4. In secondary magnetic source place, compared with primary magnetic field , if real component of secondary magnetic field is large enough，then it increases along with frequency. The imaginary component strength of secondary magnetic field on the one hand increases along with frequency, on the other hand weaken along with real component of total magnetic field weaken. Due to the total magnetic field and its corresponding real component magnetic field have the lag on phase, so primary magnetic field through underground good conductor reduces. With the increase of frequency, the induced current more and more tends to conductor edge and skin effect of eddy current appears slowly. With the continued increase of frequency, the intensity of mutual inductance is more and more big, and the real component will also continue to increase, but the magnetic flux through underground good conductor still reduce, which in turn lead to the reduction of imaginary component. When real component current $I_2 = -MI_1 / L$, electric current achieves saturation value. At this time, the imaginary component current tends to zero.

It can be seen from Figure 1： When the frequency is very low, real component of induced current and its secondary magnetic field increases approximately proportional to the square of frequency; when the frequency tends to infinity, it tends to an asymptotic value. When the frequency is very low, imaginary component of induced current and its secondary magnetic field increases approximately proportional to the frequency; at a certain frequency (Namely, $\alpha = 1$), it obtains maximum value. At this time, imaginary component and real component are basically equivalent.

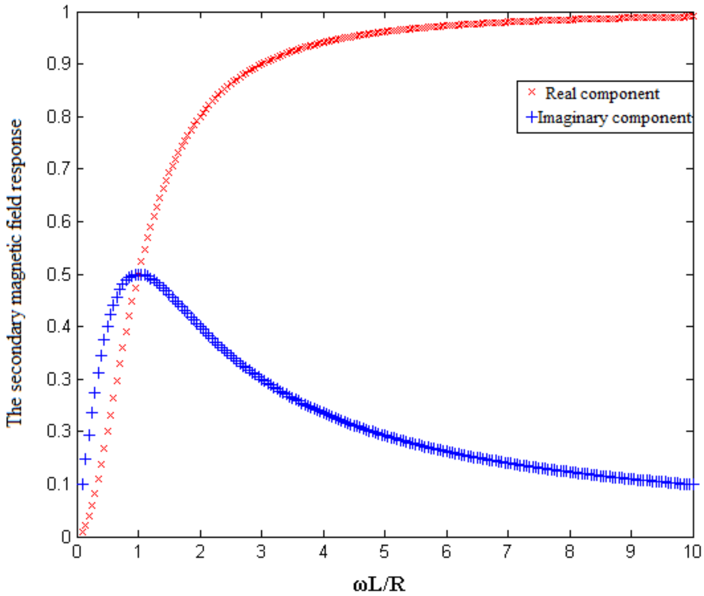

Figure 1. The frequency response of secondary magnetic field simulation diagram

3. Analysis of time characteristic on transient electromagnetic field

In the time domain electromagnetic fields, the excitation source usually use pulse waveform, and the back porch of pulse waveform is generally step change. In order to study conductor's time characteristic of time domain electromagnetic field which produce under the excitation of pulse transient electromagnetic field, the magnetic field response function of formula (1) is rewritten for:

$$D = -\frac{i\omega L}{R + i\omega L} \tag{2}$$

Do laplace change to the above formula, make $s = i\omega$, $A = R / L$, then:

$$D = -\frac{s}{A + s} \tag{3}$$

Assuming a single pulse function of emission time t is:

$$B_0(t) = \begin{cases} 1, & t < t_0 \\ 0, & t \ge t_0 \end{cases} \tag{4}$$

Then:

$$B_0(t) = 1 - u(t - t_0) \tag{5}$$

In formula (5), $u(t-t_0)$ is unit step function, its expression is:

$$u(t-t_0) = \begin{cases} 0, & t < t_0 \\ 1, & t \geq t_0 \end{cases} \tag{6}$$

Do laplace change to formula (12), then simplify:

$$B_0(s) = \frac{1}{s} \cdot \frac{e^{-st_0}}{s} \tag{7}$$

By the formula (10) and (12), getting:

$$f(t) = L^{-1}\{D \cdot B_0\} = L^{-1}\left\{-\frac{s}{A+s}\left(\frac{1}{s} - \frac{e^{-st_0}}{s}\right)\right\} \tag{8}$$

L^{-1} refers to laplace inverse transform symbol, its expression is:

$$f(t) = -e^{At} + u(t-t_0)e^{-A(t-t_0)} \tag{9}$$

Compile program in MATLAB, and get the time characteristic curve as shown in Figure 2. Figure 2 shows that when rectangular wave current of primary magnetic field is disconnected, the stimulated induced current of closed loop circuit will be exponential decay. Due to the magnetic field around the local conductor attenuates sharply, conductor produces induced current, and due to heat loss the induced current tends to disappear, making the secondary magnetic field generated by it also tend to disappear. Meanwhile, the attenuation of secondary magnetic field makes the conductor produce new induced current. Therefore, the induced current and the secondary magnetic field generated by it are a gradual process. Thus it can be seen that in a long time after power failure, we can still observe that the attenuation of the secondary magnetic field is relatively slow, which show that the position of copper mine occurring is in the geological and the electrical properties of their media is good. Because conductive property is good, secondary magnetic field can continue the long time. Observing time is long which is advantageous to the analysis of the distribution of underground copper mine.

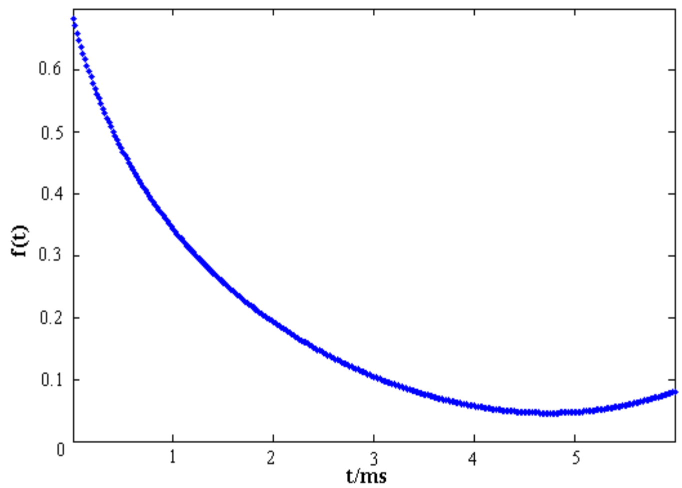

Figure 2. Time characteristic curve of transient electromagnetic field ($t_0 = 1ms$)

4. The analysis of copper anomalous field

After characteristic analysis of frequency and time of secondary magnetic field of transient electromagnetic field in Budunhua geology, and apparent resistivity curve analysis, obtaining when $t = 1.6ms$, transient electromagnetic field begins to appear obviously abnormal. The data of the emission current intensity and the magnetic field intensity of receiving coil as well as the early and late apparent resistivity are respectively processed, then carry on grid processing in MATLAB, obtain the geological distribution condition of Budunhua copper mine, as shown in Figure 8 and 9.

According to the location and morphology of geologic anomaly of transient electromagnetic field in Figure 8, it can be seen that the morphology of underground anomaly is half ring horseshoe shape and magnetic field anomaly can reach about 180 m. The transient electromagnetic anomaly amplitude is high, the width is large, and the abnormal attenuation has obvious change, indicating mineralization area is large. Abnormal fluctuation occurs underground about 50m, indicating the most shallow copper mine appears about 80m, while the deepest can reach nearly 200m. From Figure 9, it can be seen that there are 6 layer copper mine. The top of the ore body has obvious vertical abnormal amplitude, which indicates that the ore body has a strong magnetic level; the imaginary component is at the top of ore deposit, and there is obvious abnormal, indicating the covering layer influence is small, and the distribution is uneven; but the abnormal attenuation of the vertical component of bottom ore body is not obvious with the increase of time, indicating that the distribution of the deep ore body is relatively even.

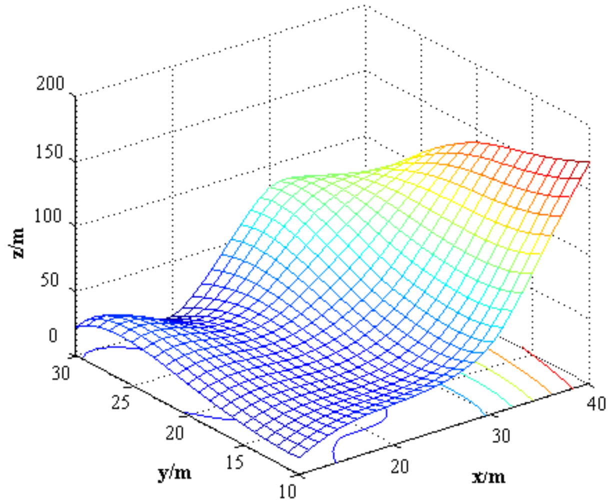

Figure 3. The three dimensional simulation diagram of abnormal magnetic field of Budunhua copper mine distribution

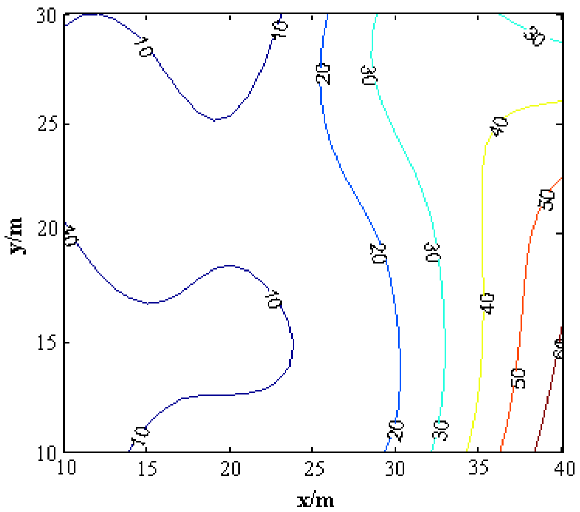

Figure 4. The two dimensional simulation diagram of abnormal magnetic field of Budunhua copper mine distribution

5. Conclusion

Compared with geophysical data, the electrical parameter of copper ore in the area are obviously different from parameter of other rock. The abnormal magnetic characteristics of earth surface reflect rock mass difference in distribution range and ups and downs situation. The density differences of massive copper ore of Budunhua area all embody the ore body distribution and abnormal situation in underground. Carry on IP scanning in Budunhua area and in turn analyze the electric field, magnetic field and gravity field characteristics. From the analysis of geophysical characteristics, the gravity field, magnetic field and electric field characteristics are all different to the effect of geological body differ. Gravity field and magnetic field abnormalities mainly reflect the ups and downs of the rock mass and the relative thickness and tectonic location of the stratum. And electric field characteristic abnormalities of the ore body can obtain the distributed situation of the corresponding copper ore body.

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