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Study on the Environmental Factors of Disturbing the Detection Accuracy of Transient Electromagnetic Method

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Abstract: In order to analyze the environmental factors which disturbs the detection accuracy of Transient Electromagnetic Method (TEM), by the means of the Time-Potential attenuation curve during data processing, comparing both the Time-Potential attenuation curves when the floor, roof and side are under or over interference source, to study all kinds of influencing factors that affect detection accuracy of TEM, as well as to make sure about main interference source while measuring all directions. Eventually, using the analysis software to correct the strong interference and improve the detection accuracy of TEM to reduce the occurrence of water damage.

Key words: TEM, interference source, detection accuracy, interference correction, water damage

INTRODUCTION

TEM is the most common and convenient methods to explore the abnormal rich water area of coal seams, tectonic location and water transmissibility among all the geophysical prospecting methods which contributes a lot to prevent and control water damage in coal mines (Yu, 1999; Yang, 1981). However, because of some anthropogenic errors, such as wrong operation of the apparatus, unclear records in the downholes, lack of taking necessary measures when it runs into metal interferences, software processing in a inflexible and stereotyped way in the latter period and so on, companying the complication of the down hole environment, the existence of the influence of the track, anchor net, joist steel, as well as the lack of uniform of the lithology, the instability of stratum, the inappropriate choice of the background values of apparent resistivity and other reasons, the explanation of the results coming from different units of the same location, the same stratum varies a lot and the results vary even much more in the certain abnormal rich water area and tectonic water transmissibility. Therefore, to decrease the outside interferences of the multi-turn small coils in the whole space and to improve the detection accuracy of TEM are emergent problems for all the geophysical prospecting workers to resolve (Yi *et al*., 2004; Wang and Liang, 2005; Tang *et al*., 2008).

MATERIALS AND METHODS

The floor, roof and side and the main parts to be detected while detecting the abnormal rich water areas in the coal mines and the metal interference sources are the track, anchor net and joist steel. As a result, the environment without interference and that with artificially added single interference source are compared to study the main interference source while measuring different directions.

The experiment spot is Pingdingshan eight mines west tunnel; the apparatus of the experiment is YCS40 (A), mine transient electromagnetic instrument; the side length of the coils is 2×2 m and the transmitting coil and receiving coil are two separate coils with different turns. There is solid support, no track, no anchor net or joist steel, or other strong interferences within the range of around 20 m. Experiment with different situations and compare and analyze the experiments by the means of the Time-Potential attenuation curve.

Measure the floor: Compare the experiments with the environment without interference and that with artificially added anchor net, joist steel and track separately and draw all the attenuation curves on the same piece of paper to analyze the main interference sources while measuring the floor. The comparison result is shown in Fig. 1.

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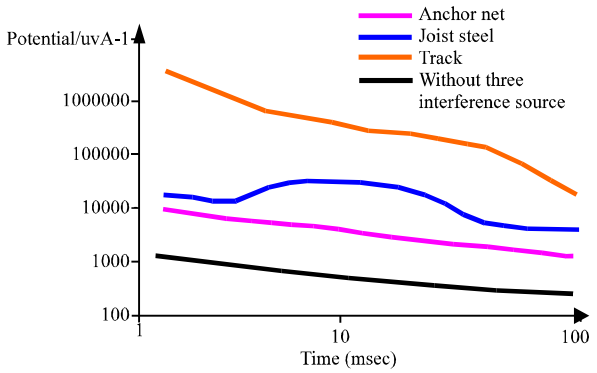

Fig. 1: The comparison attenuation curves of with or without three interference sources while measuring the floor

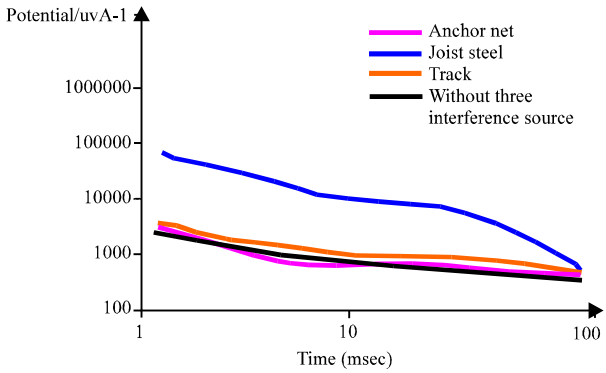

Fig. 2: The comparison attenuation curves of with or without three interference sources while measuring the roof

Figure 1 shows that the track is the main interference source while measuring the floor. Due to the skin effect, the early signal is subjected to a strong interference. The curve representing the interference of the track is higher than the normal three orders of magnitude and as time increases, the detection depth also increases which is why the impact that the floor track has on the transient electromagnetic signal decreases in the latter period, but it's still two orders of magnitude higher than the normal. In the early stage, the curve representing the interference of the joist steel is higher than the normal one order of magnitude. Since the joist steel is on the roof, it takes some time to propagate the signal which is why the phenomenon of the sudden potential increase emerges in the middle late stage. It means that the joist steel has an effect on transient electromagnetic detection signal which cannot be ignored. The trend of the curve representing the interference of the anchor net is substantially the same with the normal from the early stage to the late stage, but it's still higher than the normal one order of magnitude. Consequently, the influence strength in descending order should be the track, the joist steel and the anchor net while measuring the floor and adequate attention should be paid while analyzing the data.

Measure the roof: Likewise, compare the experiments with the environment without interference and that with artificially added anchor net, joist steel and track separately and draw all the attenuation curves on the same piece of paper to analyze the main interference sources while measuring the roof. The comparison result is shown in Fig. 2.

Figure 2 shows that the potential curve representing the joist steel is higher than the other three about two

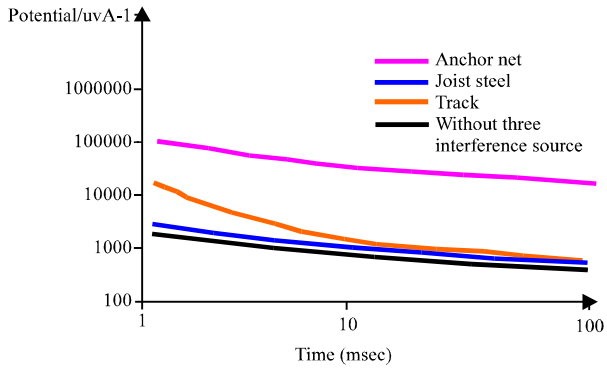

Fig. 3: The comparison attenuation curves of with or without three interference sources while measuring the side

orders of magnitude which shows that the joist steel is the main interference source while measuring the roof while the curves representing the track and the anchor net generally align with the black normal one which means that the joist steel is the main interference source while measuring the roof and attention should be given during software processing in the late stage.

Measure the side: Similarly, compare the experiments with the environment without interference and that with artificially added anchor net, joist steel and track separately and draw all the attenuation curves on the same piece of stuay to analyze the main interference sources while measuring the roof. The comparison result is shown in Fig. 3.

From Fig. 3, it can be seen that the anchor net is the main interference source while measuring the side, since the anchor net is close to the coil. It also shows that

the curve representing the anchor net is higher than the normal two orders of magnitude which means that the anchor net has a strong effect on transient electromagnetic signal while measuring the side. Since the track is also close to the coil while measuring the side, the curve representing the track shows an obvious potential value increase in the early stage, one order of magnitude higher than the normal, but in the late stage, as the detection depth increases, the curve representing the track almost coincides with the normal which means that the track only has little effect on transient electromagnetic signal. The trend of the curve representing the interference of the joist steel is the same with the normal potential curve which means that the joist steel has very little effect on the transient electromagnetic signal from the beginning to the end and attention should be especially paid to the influence from the anchor net and the track in the early stage.

EXAMPLE AND RESULTS

In the complex downhole environment, there will be the interference from the track, anchor net and joist steel, etc. which makes the Measuring point-Voltage graph distort and affects the final result of the transient electromagnetic detection. Therefore, the interference correction by analysis software is needed. Here the example of the Pingdingshan Coal Mine Shoushan is taken to illustrate the correction method of eliminating interference sources.

Figure 4 shows the Measuring point- Voltage graph of the unprocessed point 90. During the measuring, according to the record in the downhole, there is a large number of iron accumulation at measuring point 90. From the Time-Voltage graph, it can be seen clearly that it is not a standard image "Yi" shape, but the phenomenon of the emergence of the decrease of voltage, so it's sure that this

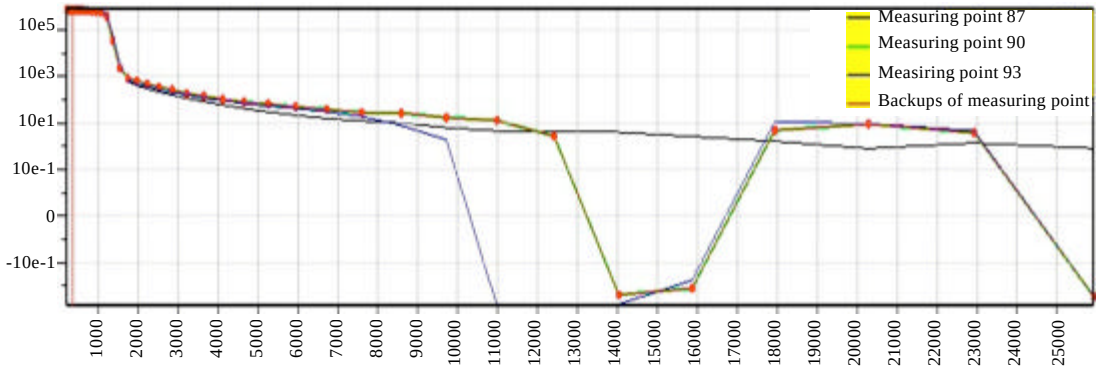

Fig. 4: Measuring point-voltage graph of the unprocessed point 90

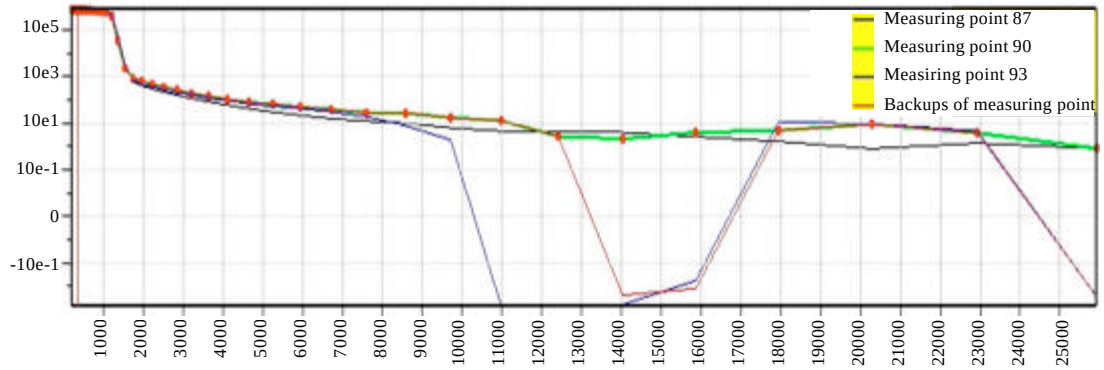

Fig. 5: Time-voltage graph of point 90 by correction of single-point

point is interfered by iron or other pollutants (Xue *et al*., 2007; Song, 2009). This point should be moved during software analysis and corrected according to accurate points around.

During the single-point movement correction, the actual record in the downhole should be followed and the point without interference should be selected to help correct. Correction should be based on the points before and after the disturbed point on the Time-Voltage graph and the distorted curve can be corrected to the normal curve trend by the single-point correction (Du and Li, 2006). If there still exists the phenomenon of the sudden voltage change in the Measuring point-Voltage graph, correction according to the accurate points around is needed. It can make the final result get closer to the true result to select many interference-free measuring points beside the correcting point. After the first two correction steps, smoothing process is needed, smoothing the entire curve. Figure 5 shows the Time-Voltage graph which has been corrected by single-point movement and near point correction. The corrected Time-Voltage graph is a standard image "Yi" shape which is closer to the actual situation.

CONCLUSIONS

Through the detection, it's found that the influence strength in descending order should be the track, the joist steel and the anchor net while measuring the floor.

The joist steel is the main interference source while measuring the roof, while the track and the anchor net has little effect on the result. The record of joist steel should be strengthened and attention should be given during software processing in the late stage.

The anchor net is the main interference source while measuring the side and the joist steel has little effect on the transient electromagnetic signal, while the track only has little effect on transient electromagnetic signal in the early stage which means the interference correction is still needed.

During the software processing stage, the final curve can get close to the true value by correcting the data that has been influenced by metal interference through single-point movement and near point correction, according to the record of the stage of data collection.

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