O13-1 LOCATING SHALLOW LATERAL DISCONTINUITIES BY THE TWO-SIDED GRADIENT TRANSFORMATION

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Introduction

In this study, we introduce a new data analysis technique in Direct Current Resistivity (DCR) method for detecting buried objects in an archaeological area.

In the DCR method, if the survey is carried out with different electrode configurations, each will produce a different response over the same geological structure. The measured value is actually an integral of the volume between the electrodes, and the investigation depth depends on position of the current and the potential electrodes (Roy and Apparao, 1971).

Previous studies showed that two-sided three-electrode configurations are more suitable than classical full arrays (e.g. Schlumberger, Wenner) over a complex geology (e.g. Barker, 1981; Karous and Pernu, 1985; Schulz and Tezkan, 1988). The advantage of this electrode configuration is that profiling and sounding is combined. Karous and Pernu (1984) employed this electrode array and they claimed to get the maximum information about the buried object.

Data Processing

From the geological point of view, subsurface is usually very complex. However simplified two-dimensional (2-D) or three-dimensional (3-D) models such as faults or buried small objects may be used to approximate the real conditions. Over the 2-D or the 3-D setting, resistivities r_{aA} and r_{aB} measured by using two-sided three-electrode configuration are not equal. Their differences may be used to locate the source of this discrepancy. Also using these differences some further information can be obtained about the location of the target. Karous and Pernu (1985) defined Gradient (G) Transformation as

$$G^{i}(x)=\frac{r^{i}{}_{aA}(x)}{r^{i+1}{}_{aA}(x)}+\frac{r^{i}{}_{aB}(x)}{r^{i-1}{}_{aB}(x)}-2 \qquad (i=2,3,\cdots,M-1) \qquad (1).$$

where x is the spacing along the profile, equal to the distance $\overline{AO}$ and M is the number of the station. Karous and Pernu (1985) have used Gradient transformation for finding resistive dyke. Similarly another relation can be given as

$$TSG^{i}(x)=\frac{r^{i}{}_{aA}(x)}{r^{i+1}{}_{aA}(x)}+\frac{r^{i}{}_{aB}(x)}{r^{i\text{-}1}{}_{aB}(x)}+\frac{r^{i}{}_{aA}(x)}{r^{i\text{-}1}{}_{aA}(x)}+\frac{r^{i}{}_{aB}(x)}{r^{i+1}{}_{aB}(x)}-4 \qquad (2)$$

This transformation is called “Two-Sided Gradient Transformation (TSG)" (Candansayar, 1997).

G and TSG transformation can be used to determine the near surface discontinuity and it may be used in archaeological investigations (finding ruins of wall, or tomb etc.). These interpretation techniques give some information about the location of the target objects.

It is known that the square power of any number that less than 1 is smaller than itself. On the other hand, if the number is greater than 1, the result will be bigger than itself. This idea may also be used to obtain a new transformation formulas as

$$G'^{i}(x) = \left(\frac{r^{i}_{aA}(x)}{r^{i+1}_{aA}(x)}\right)^{j} + \left(\frac{r^{i}_{aB}(x)}{r^{i-1}_{aB}(x)}\right)^{j} - 2 \tag{3}$$

$$TSG'^{i}(x) = \left(\frac{r^{i}_{aA}(x)}{r^{i+1}_{aA}(x)}\right)^{j} + \left(\frac{r^{i}_{aB}(x)}{r^{i-1}_{aB}(x)}\right)^{j} + \left(\frac{r^{i}_{aA}(x)}{r^{i-1}_{aA}(x)}\right)^{j} + \left(\frac{r^{i}_{aB}(x)}{r^{i+1}_{aB}(x)}\right)^{j} - 4 \tag{4}$$

where j = 1, 2, 3, … i.e, it could be any positive integer . However, in the present study the value of 2 was assessed to j. This process exaggerates the noise effect in the case of low signal-noise ratio.

These transformation techniques examined by using the synthetic data and the field data. Synthetic data were calculated by using 2-D finite element modelling code (Uchida and Murakami, 1990). The response of the two-sided three-electrode configuration was computed and then the transformations were applied. The TSG and TSG' clearly located the location of the buried objects rather than G and G' respectively.

The transformations tested on real data collected in an archaeological side in Alacahoyuk in central Turkey. TSG and TSG' showed clearly a concealed defence wall while G and G' presented only local anomaly respectively. The excavation verified the geophysical result.

Conclusion

Extending the work of Karous and Pernu (1985) two more terms were added to G, and new transformation is called TSG, improving the sensitivity of the transformation process. This study proved that TSG is more efficient in delineating the shallow lateral discontinuities.

This method can be successfully used in archaeological investigations. It seems that the TSG transform is advantageous over than G transform. This fact was demonstrated both by synthetic examples and the real data. Both transformations remove effect of horizontal discontinuity and increase the effects of the lateral discontinuity.

Instead of doing 2D or 3D inversion, we use the fast TSG technique for quick interpretations.

Two-sided three-electrode configuration can be used with efficiency in archaeological investigation.

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