

Fault Trend Detection Using Three-Dimension Pole-Pole Array (A Case Study in Anarak Area)

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Abstract:

Resistivity electrical changes in vertical, horizontal and in the direction that is perpendicular to the survey line, is measured in 3D surveys. 3D electric data illustrate a 3D image from subsurface layers, therefore combination of 3D electric results and surface geology is appreciated as helpful technique in electric data interpretation. What is carried out for performing a 3D survey is as follows: first a 2D survey is carried out in the survey field and then collected data are interpreted. When the subsurface layers are defined clearly, an area is selected and a suitable grid for 3D survey is designed. After data acquisition, by using a 3D interpretation software, data points are interpreted. Finally, the results are compared with the result of 2D configuration. In this study, the main objective is the detection of a fault trend by using pole-pole electrode array which is commonly used for 3D surveys. This survey method by using a 3D interpretation model gives accurate results of subsurface structures. In order to confirm the abilities of this method for fault detection, after checking the final results of 2D Shlumberger array on a fault trend in Anarak area in Esfahan province, an square grid with a 60 meters long, was designed and data acquisition was carried out. Then potential values (476 data points) were inserted into a provided program in MATLAB software for calculation the apparent resistivity. After data interpretation by using RES3DINV software, the fault trend was detected in vertical and horizontal sections. At the end apparent resistivity values and the coordinates of data points were inserted into the Slicer/Dicer software and a 3D structural model of different horizons from surface to subsurface was produced. The results show considerable ability of 3D surveys for fault detection.

Keywords: *Geo electrical 3D surveys; Pole-Pole array; Fault trend detection;*

1- Introduction:

The 3D survey is found to be a useful technique for 3D geo electrical interpretation. At the present time, what is carried out for performing a 3D geo electrical survey is as follows: first a 2D survey is carried out in the survey field and then collected data are interpreted. When the subsurface layers are defined obviously, an area is selected and a suitable grid for 3D survey is designed. After data acquisition, by using 3D interpretation software, data points are interpreted. Finally, the results are compared with the result of 2D configuration. Articles and reports published in this field, indicate the high ability of this method with an acceptable accuracy compared with 2D surveys. Based on this, after 2D measurements were done in Anarak area in Esfahan province, 3 fault trends was detected in the mentioned area. With studies on the location map and topography of the region, an area between sondages k12 and k13 (Figure 1), was selected for geo electrical 3D network designing.

2- The geology of the study area

This area in terms of geologic divisions is a part of central Iran. One of the areas in which metamorphic rocks are found, is along a fault trend what is visible in the study area. Obvious features of the area's rocks are weathering and foliation. The metamorphic rocks of the study area are: mica schist, phyllite, gneiss, quartzite and chlorite schist. Figure 2 show a sample of field's geology.

3- Data acquisition by using 3D pole-pole array

In this study, 3D pole-pole array, "cross-diagonal survey" technique, is used. In this technique for a 7 by 7 electrode grid, the number of datum point is 476. In the measurements sequence shown in figure 3, each electrode in turn is used as a current electrode and the potentials measurements are made at the electrodes along the horizontal, vertical and the 45 degree diagonal lines passing through the current electrode. Note that because of reciprocity, it is only necessary to measure the potentials at the electrodes with a higher index number than the current electrode. In practice, the ideal pole-pole array with only one current and one potential electrode does not exist. To approximate the pole-pole array, the second current and potential electrode (C2 and P2) must be placed at a distance which is at least 10 times the maximum separation between c1 and p1 electrodes used in the survey to insure that the error is less than 5%. So in this survey, the electrode p2 was placed at 300 meters and the electrode c2 was placed at 600 meters far from the network (Figure 4). Note that because of the large distance between the p1 and p2 electrodes, it picks up a large amount of telluric noise which can severely degrade the quality of the measurements so before carrying out these measurements, it is necessary to make sure there would be no solar storms which is the most factors to make these noises.

4- Horizontal sections

After applying the inversion, 6 sections were introduced by RES3DINVERS software as horizontal sections (Figure 5). These sections cover from the surface to the depth of 77.5 meters. As the figure shows, from the surface to the depth of 24.3 meters, apparent resistivity changes up to 350 ohm meter. From the depth of 24.3 meters to 35 meters, apparent resistivity changes between 350 to 800 ohm meters and from the depth of 35 meters to 75 meters, the value of apparent resistivity is about 2500 ohm meter. As sections number 1, 2 and 3 show, blue layer can be recognized from the surface up to the depth of 24.3 meters.

5- Vertical sections:

In figure 6, vertical sections which are parallel with the fault trend are shown. Vertical drop of blue layer from surface up to the depth of 19.7 meters is clearly visible. From the depth of 19.7 meters to bottom, layers are almost horizontal. It is proved that in line which is parallel with fault's trend, apparent resistivity changes are very minor and the sections show this fact as well. Vertical sections which are perpendicular to fault's trend are shown in figure 7 . From section 2 up to section 5, the fault trend is clear. It is proved that in line perpendicular to a fault, the change in the sections is totally clear which these sections confirm this fact as well.

6- 3D image of the subsurface layers by using Slicer/Dicer software

RES3DINV software enables the user to get the output under the extension gm after the inversion. The file is made with this suffix is used as an input for Slicer/Dicer software to provide a 3 dimensional structure. Figure 8, shows a 3D image of subsurface structure which has been produced by this software.

7- Discussion and Conclusion

This array has the widest horizontal coverage and the deepest depth of investigation so the pole-pole array might be a suitable choice for surveys with small electrode spacing and when good horizontal coverage is required. In a 3D survey, a large amount of data point is read so the user can get an image of subsurface layers with high quality and less noise. Nowadays, considerable researches in the field of geo electric exploration are done. However, because of the large number of data points, operation's time and the cost are high but it is expected that in a near future with development in multi-channels measuring devices, which enable the users to read several data points simultaneously, and the progress in interpretation software, that enables the users to have the interpretation of a lot of data points (more than 8000 data), the mentioned problems will be solved and this method will be a suitable alternative for geo electric 2D surveys.

8- References

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Figures

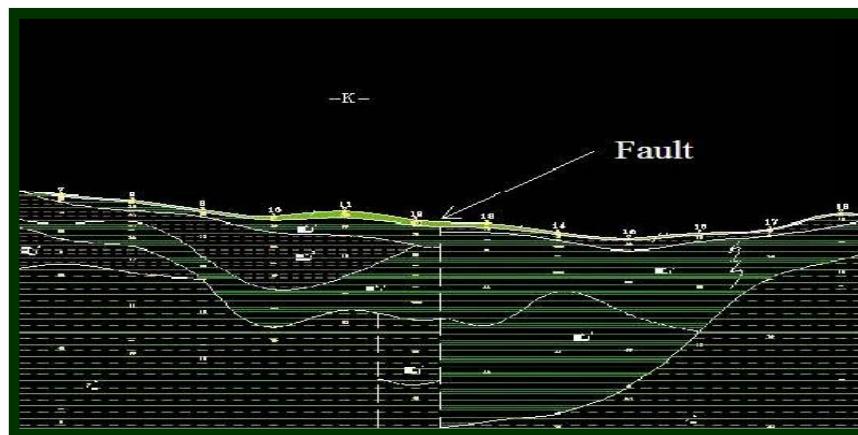


Figure1. The area which was selected between sondages k12 and k13 is shown



Figure2. A view of field's geology

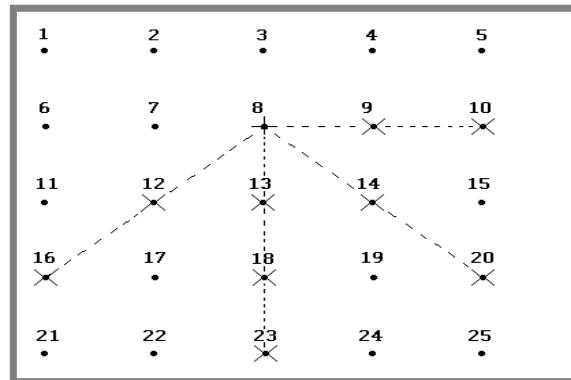


Figure3. An image of the way that the measurements are done

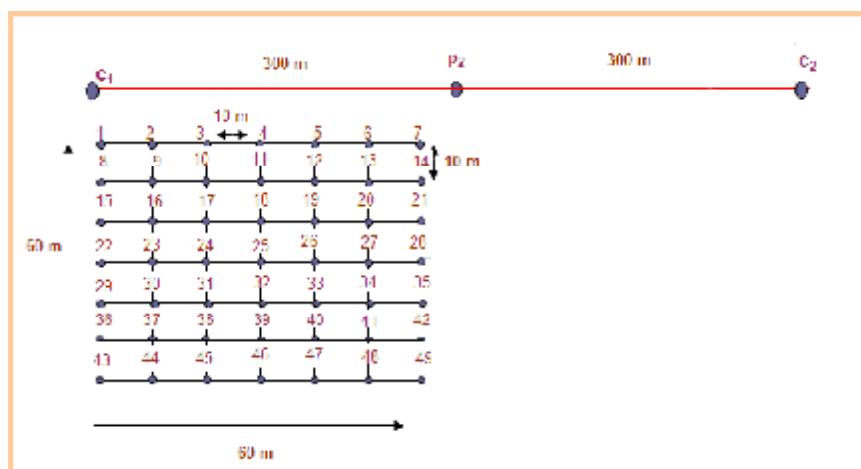


Figure4. The electrode p2 is placed at 300 meters and the electrode c2 is placed at 600 meters

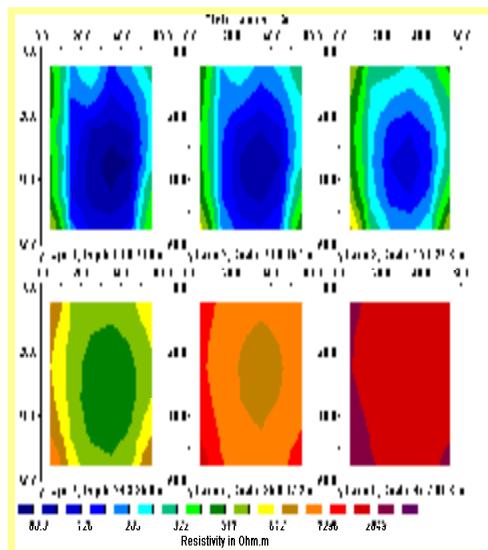


Figure5. Horizontal sections

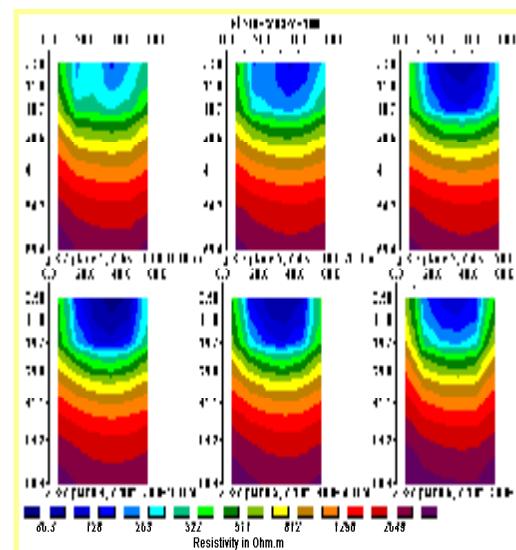


Figure6. Vertical sections which are parallel to fault's trend

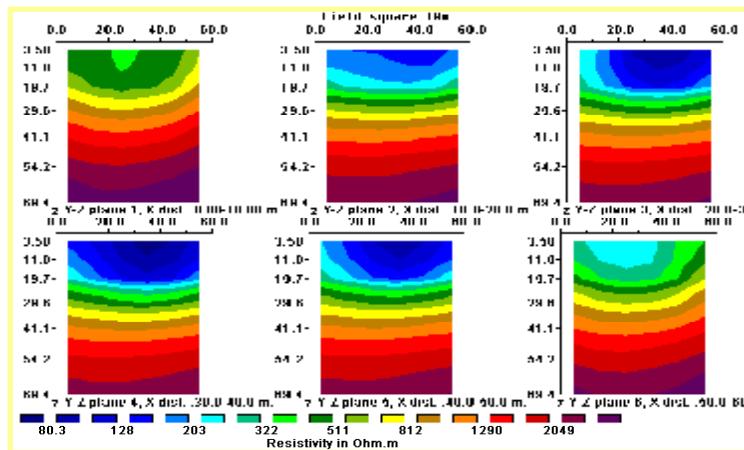


Figure7. Vertical sections which are perpendicular to fault's trend

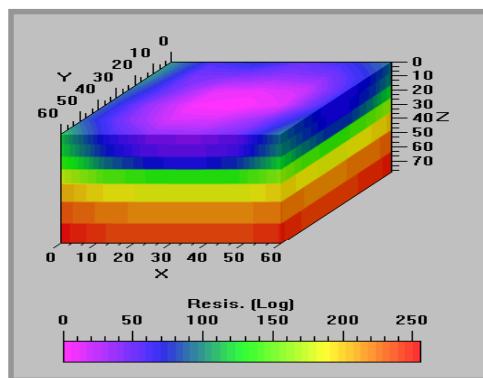


Figure8. The 3D image made by Slicer/Dicer software