Subsurface prediction using resistivity method (Case study: Bira, South Sulawesi, Indonesia)

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Abstract. Resistivity method is one of active geophysics method which is used electric current on subsurface. Resistivity method studies rock resistivity characteristic beneath line measurement. Bira is one of tour destination in Bulukumba Regency, South Sulawesi. This area is developing for serving tourists well. The aim at this research is to predict lithology subsurface in this area based on resistivity profile to give information for that activity. Based on geology, Bira consists of Tacipi Limestone Member of Walanae Formation. We used Wenner-Schlumberger configuration and data processing used the cell-based method inversion. The result of resistivity survey has two categories. The first are low resistivity around 1.93 – 13.9 Ωm, estimated as fresh groundwater on 10 – 30 meter depth. The second is medium to high resistivity around 13.9 – 518 Ωm, predicted as limestone on 0 – 10 meter depth.

1. Introduction

Resistivity method is one of active geophysics method which is used electric current on subsurface. This method is easy to use, environment friendly and commonly low cost. Many researches used this method of variety necessaries, for example Aal in Riyadh, KSA [1] and McCormack et al. in Western Ireland [2] for karst cave identification and Harimei et al in East Borneo for port planning [3]. Resistivity method studies rock resistivity characteristic beneath line measurement. Several ranges of resistivity values shows by Figure 1.

One of uniqueness from resistivity method is electrode composition which is delivering electric current to subsurface called electrode configuration. The configuration has many kinds and used appropriate with depth target. One of them is Wenner-Schlumberger Configuration. This configuration used for 2D resistivity measurement of deep target. Some kind of configuration shows by Figure 2.

Bira is one of tour destination in Bulukumba Regency, South Sulawesi. This area is developing for serving tourists well. The information about subsurface needed to that activity. The aim at this research is to predict lithology subsurface in this area based on resistivity profile. Based on geology, Bira consists of Tacipi Limestone Member of Walanae Formation (Figure 3) [5]. This unit consists of coral limestone, calcarenite with marl inserted and sandstone. This formation suggested Miocene to Pliocene and formed by South Sulawesi uplift [5].
Figure 1. The resistivity value range of rocks, soils and minerals [4].

Figure 2. General electrode configuration with their geometric factor. C is current electrode and P is potential electrode. a is minimum space of electrode and n is integer value [4].
2. Method and Data

We used Wenner-Schlumberger configuration because our target is deep. The line consists of 30 numbers of electrodes and 10 meters space. This acquisition has NE – SW direction. Data acquisition has done on noon and fine weather to minimize noise.

Data processing used the cell-based method inversion [4]. This method make resistivity value of model cells as model parameter. The data is as observed apparent resistivity value and to connect them, used mathematical formulation. To get best result, this method used least-square optimization for error calculation. So, this method commonly called least-square inversion. The display of result used X2IPI programs [6] which uses finite element method of forward modeling [7].
3. Result and Discussion

The resistivity cross-section of the first line shows on Figure 4.

![Figure 4. The resistivity cross-section with topography.](image)

Figure 4 show resistivity cross-section from five iteration with RMS Error 15.473%. On cross-section, the lowest resistivity value point is in 82.5 meters and around 27.5 meter depth. The highest resistivity value point is 7.5 – 15 meters and around 2.5 – 5 meter depth.

This inversion results give two categories of resistivity value range. The first categories have low resistivity 1.93 – 13.9 Ωm and the second have medium to high resistivity 13.9 – 518 Ωm. In comparison with the resistivity value range (Figure 1), the low resistivity indicate limestone permeable layer which predicted filled by fresh groundwater on 10 – 30 meter depth. The medium to high resistivity on 0 – 10 meter depths showed limestone which appropriate with the geological condition of the research area. Limestone well known has high porosity and permeability so that fresh groundwater can reach surface through this rock.

4. Conclusions

The resistivity cross-section result of research area has two categories of resistivity value range, are low resistivity 1.93 – 13.9 Ωm and medium to high resistivity 13.9 – 518 Ωm. Low resistivity indicates limestone permeable layer with fresh groundwater on 10 – 30 meter depths. Medium to high resistivity shown limestone on 0 – 10 meters.

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