Coal Layer Identification using Electrical Resistivity Imaging Method in Sinjai Area South Sulawesi

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Abstract. The purpose of this research is to image subsurface resistivity for coal identification in Panaikang Village, Sinjai, South Sulawesi. Resistivity measurements were conducted in 3 lines of length 400 meters and 300 meter using resistivity imaging, dipole-dipole configuration. Resistivity data was processed using Res2DInv software to image resistivity variation and interpret lithology. The research results shown that coal resistivity in Line is about 70–200 Ωm, Line 2 is about 70–90 Ωm, and Line 3 is about 70–200 Ωm with average thickness about 10 meters and distributed to the east of research area.

1. Introduction
1.1 Background
Coal is a mineral material composed of organic mascerals and little nonorganic elements. Coal was formed by plants that lived in freshwater environments, commonly grew in the tropics. Coal as one of the substitute for petroleum fuels, in the future will be expected to play a big role in Indonesia, as an alternative fuel.

Based on the Regional Geology of Sulawesi, coal in South Sulawesi can be found in several formations, such as the Mallawa Formation, Walanae Formation, Camba Formation and Toraja Formation, with different characteristics in each formation. Generally coal in South Sulawesi includes lignite, it was formed into Tertiary, Eocene and Neogen [1]. Coal outcrops in Sinjai distributed irregularly. Coal is a type of lignite deposited in ancient tidal environments. One part of the area that has an outcrop of coal is administratively located in Panaikang Village.

One of geophysical methods can be used to identify subsurface lithology is resistivity method. This methods consists of some acquisition techniques, such as sounding (VES) and imaging. Sounding (VES) measures resistivity variation vertically using Schlumberger configuration and imaging measures resistivity variation vertically and laterally using Wenner, Wenner-Schlumberger, and Dipole-dipole [2]. In this research, imaging acquisition technique was conducted using Dipole-dipole configuration. This configuration can image resistivity variation laterally well and moderate depth accuracy [3]. So it is better to identify coal distribution laterally in research area.

1.2 Geological Consideration
Based on geological map (figure 1), Panaikang area lies on Walanae Formation (Tnpw) and Alluvium, Swamp, and Coastal Deposits (Qac). Walanae Formation (Tnpw) aged late Miocene–Pliocene, this formation overlapped with the Camba Volcano Rock Formations. The Walanae Formation is composed of sandstone, conglomerates, and tuffs with limestone inserts, claystone, limestones, napal and lignite, medium to coarse grained sandstones. The thickness of this unit is estimated to be about 1.200 meters. Alluvium, Swamp, and Coastal Deposits (Qac) consists of clay, silt, sand, mud, and gravel along large rivers and beaches. Local coastal deposits contain seashells and coral limestones [1]. Coal outcrop in research area is lignite, part of lithology of Walanae Formation (figure 2). This outcrop reveals coal potency in research area and to be interesting to investigate the distribution of coal as pre-eliminary study.
2. Methods
Panaikang Village, Sinjai Regency, South Sulawesi geographically located between 120° 14’ 39.4” E – 120° 16’ 59.2” E and 5° 9’ 28.5” S – 5° 11’ 26.4” S. Resistivity measurements were conducted using resistivity meter Naniura NR 300, four electrodes consist of two current and potential electrodes. These electrode were injected into the soil surface based on predetermined distance, then the electrical current was flowed through current electrodes into subsurface. The potential electrodes will measure potential difference from the electrical current injected [4]. The apparent resistivity value is calculated using potential difference data, electrical current injected, and geometry factor of dipole-dipole configuration and the real resistivity is calculated by using inversion method applied by Res2DInv software [5]. The resistivity measurement in this research consist of three lines. They are Line 1 and
Line 2 have 400 meters in length, and Line 3 has 300 meters in length. The acquisition in Line 1 was conducted on coal outcrop to get resistivity variation on coal layer directly and this resistivity value became reference to interpret coal layer in other lines. Line 2 and Line 3 was conducted parallel with Line 1 to identify continuity and distribution direction of coal. The minimum distance of electrodes for each line is 5 meters.

![Figure 3. Schematic Diagram of Dipole-dipole Configuration [6].](image)

The apparent resistivity is calculated by using the following equation where \( V \) (potential difference), \( I \) (electrical current) and \( k \) (geometry factor of dipole-dipole configuration) [7].

\[
\rho = k \frac{V}{I} \quad (1)
\]
\[
k = \pi n (n + 1)(n + 2)a \quad (2)
\]

Data inversion was processed by using Res2DInv software to image real resistivity of subsurface vertically and laterally.

3. Results and Discussion

Result of resistivity processing using Res2DInv software for Line 1 shown on the following figure 4.

![Figure 4. Distribution of Resistivity in Line 1.](image)

Figure 4 shows distribution of resistivity in Line 1. The variation of resistivity starts from 0.82 Ωm to 200 Ωm with the depth about 80 meters from surface. Interpretation of resistivity imaging in Figure 4 revealed that distribution of coal resistivity is about 70–200 Ωm, this resistivity variation will become reference to interpret coal layer in other lines. The thickness of coal layer is about 10 meters and tends to distribute to the east of research area. Others lithology can be interpreted from the resistivity value are wet clay with resistivity value about 0.82–20 Ωm and silt or sandy clay with resistivity value about 20–70 Ωm.
Figure 5. Distribution of Resistivity in Line 2.

Figure 5 shows distribution of resistivity in Line 1. The variation of resistivity starts from 4 Ωm to 90 Ωm with the depth about 80 meters from surface. Interpretation of resistivity imaging in Figure 5 revealed that distribution of coal resistivity is about 70–90 Ωm. The thickness of coal layer is about 10 meters and tends to distribute to the east of research area. Others lithology can be interpreted from the resistivity value are wet clay with resistivity value about 4–10 Ωm and silt or sandy clay with resistivity value about 10–70 Ωm. This line is near and parallel with Line 1 and reveals similarity of coal resistivity distribution.

Figure 6. Distribution of Resistivity in Line 3.

Figure 6 shows distribution of resistivity in Line 1. The variation of resistivity starts from 1.3 Ωm to 300 Ωm with the depth about 60 meters from surface. Interpretation of resistivity imaging in Figure 6 revealed that distribution of coal resistivity is about 70–200 Ωm. The thickness of coal layer is about 10 meters and tends to distribute to the east of research area. Others lithology can be interpreted from the resistivity value are wet clay with resistivity value about 1.3–10 Ωm, silt or sandy clay with resistivity value about 10–70 Ωm, and tuff with resistivity value about >200 Ωm.

Compared with relevant research about coal resistivity value using resistivity imaging shown that coal resistivity ranging from 100 Ωm to 400 Ωm [8]. So, coal resistivity in this research is 70 Ωm to 200 Ωm adequately similar with other reference.
4. Conclusion
Resistivity investigation of coal resistivity distribution in Panaikang Village, Sinjai, and South Sulawesi had conducted successfully. Resistivity measurements were conducted in 3 lines with length 400 meters for Line 1 and Line 2 and 300 meter for Line 3 using resistivity imaging, dipole-dipole configuration. Resistivity data was processed using Res2DInv software to image resistivity distribution variation. The research results shown that coal resistivity in Line is about 70–200 $\Omega$m, Line 2 is about 70–90 $\Omega$m, and Line 3 is about 70–200 $\Omega$m with average thickness about 10 meters and distributed to the east of research area. Based on this research, the coal in Panaikang Village is potential for mining.

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