Interpretation of Slip Surface and Weathered Layer Using the Geoelectric Method with Dipole-Dipole Configuration (Case Study of Ulu Kasok Hill, Kampar Regency)

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Abstract. Ulu Kasok Hill is a famous tourist attraction called Raja Empat, Kampar Regency. This peak is not only visited by visitors but vehicles such as motorbikes and cars also go up to the top. Survey of resistivity geoelectricity is one of the geophysical methods in investigating slip surface and weathered layers to determine the potential of land movement (landslides). The dipole-dipole configuration method describes the shape of the slip surface, the type and depth of the weathered layer in two dimensions. The 68 meter cross section with 2 meter electrode spacing illustrates the subsurface layer on 4 different trajectories. Interpretation of the results of the study on each path shows that the slip surface are clays (Dry) to mudrock with resistivity ranging from 101 Ωm - 208 Ωm and the type of weathered layer is soil until the clay sand is found in a depth range of 0.342 meters - 5.41 meters. The results showed that trajectory 3 has the largest weathered layer thickness.

1. Introduction
Ulu Kasok Hill is located at the western part Kampar Regency, Riau Province, Indonesia. This area is the center of tourist attraction because it is surrounded by hills and rivers. Due to the morphology of this area, is of concern to researchers because the potential for natural disasters is very high, especially landslides. One tourist attraction that is currently being visited by tourists is Ulu Kasok Hill, XIII Koto Kampar District. Recorded in XIII Koto Kampar District, is an area that has the potential for moderate to high soil movement [1]. Soil movements (landslides) occur in the slip surface below the water-resistant soil surface. When rainfall is high and water seeps into the ground touching the slip surface, then there will be ground movement outward through the slip surface [2].

The theory of landslide movement can be studied from the shape and structure of the subsurface layer by collecting geological information and through research studies using the resistivity geoelectric method. This method is very simple and does not damage the structure of the soil surface or the subsurface layer. The application of geoelectric methods in geophysics produces an interpretation of the subsurface rock layers in 2 dimensions by comparing the resistivity values of each of the constituent layers [3]. This research was conducted on Ulu Kasok Tourism Object, XIII Koto Kampar District, Kampar Regency, Riau Province, specifically as a description of landslide disaster mitigation to minimize incidents.
The geoelectrical resistivity method have been widely in the exploration of the subsurface. The method can be used to investigate the quality of groundwater [4-6]. It also can be used in the karst area [7] and hydrothermal investigation [8]. The aim of this research is to interpret the subsurface of the slope in term of the landslide investigation in the Hulu Kasok hill, Kampar.

2. Methodology
The research started with the stage of field survey, literature study to interpretation and conclusions to determine the potential for soil movement by identifying the skid and weathered layers in Ulu Kasok Tourism Object, XIII Koto Kampar District, Kampar Regency, Riau Province. The research was carried out in 4 tracks with a length of each track that was 68 meters with quite steep slope conditions. The choice of configuration in the geoelectric affects the results of the interpretation of layers depending on conditions in the field. Dipole-Dipole configuration is very suitable to be used in this study because the data signal strength reads very well both horizontally and vertically.

This study used the Geoelectric method with a configuration namely Dipole-Dipole. The current electrode and voltage electrode were separated by the distance between electrodes, \(a = 2 \text{ meters and } n = 1-22\). The study was conducted with 2 steps. The first stage i.e. field data acquisition was carried out to obtain the voltage \((V)\), current \((I)\) and resistivity values. The resistivity values obtained in the field were still in the form of apparent resistivity, and were then be processed using RES2DINV software to see a 2-dimensional stretch by obtaining the actual resistivity value. This software will correct data as the initial processing stage, to eliminate small disturbances that exist at apparent resistivity. The second stage, taking rock samples carried out on rock outcrops of the excavation that appears on the slopes of Ulu Kasok Hill provided that each sample is taken different in shape and color in order to distinguish the type and name of the rocks.

Analysis of the slip surface and weathered layer was done by comparing the resistivity values of various types of soil / rocks / minerals obtained by the literature resistivity value. Furthermore, data from laboratory testing, image 2 Dimensions of measurement results and geological information will be juxtaposed interpreted to obtain the composition of subsurface rock layers.

3. Result and Discussion
The rock formation at the research location is known based on its geographical coordinates using ArcGis Software. It was found that the study location was in the Bahorok formation with the code of PUB formation. Geologically, Bahorok sedimentary rock formations consist of wackes rock formations, wacke conglomeratic, turbidites and intrusive breakthrough rocks, namely gadang island granite like foliages, part granite genes [9]. Interpretation of slip surface and weathered layers refers to the determined resistivity values as shown in table 1.

| Material Types          | Value of resistivity (Ωm) |
|-------------------------|---------------------------|
| Quartz                  | \(3 \times 10^2 - 10^5\) |
| Rock salt               | \(30 - 30^{13}\)         |
| Granite                 | \(3 \times 10^2 - 3 \times 10^6\) |
| Consolidated shale      | \(20 - 2 \times 10^3\)    |
| Conglomerates           | \(2 \times 10^3 - 10^4\)  |
| Sandstones              | \(8 - 4 \times 10^3\)     |
| Clays                   | \(1 - 100\)              |
| Top soil                | \(250 - 1.700\)          |
| Clay (very dry)         | \(50 - 150\)             |
| Sand clay / clayey sand | \(30 - 215\)             |
| Silt – Clays            | \(10 - 200\)             |
The results of the study are displayed in the form of a 2 Dimensional (2D) collection point collection obtained from field observations and then processed using RES2DINV Software. The following results of the research are shown in Figure 1 (A), (B), (C), and (D).
Figure 1. The geoelectrical resistivity interpretation

Based on Figure 1 (A) a 2-dimensional (2D) cross section is obtained on the first track with the resistivity value in the first layer smaller than the resistivity in the second layer. According to Table 1, the resistivity value in the first layer is 96.3 Ωm - 153.6 Ωm interpreted as a weathered layer with a type of sand clay at a depth of between 0.342 meters - 2.57 meters, and the second layer obtained a resistivity value of 153.6 Ωm - 245 Ωm is interpreted as a slip surface with a type of Dry clay to mudrock. Furthermore, the second track (Figure 1 (B)) has a resistivity value in the first layer is 62.3 Ωm - 88.1 Ωm interpreted as a weathered layer with soil rock types to sand clay at a depth between 0.342 meters - 4.40 meters and layers second, the resistivity value of 124.6 Ωm - 176.2 Ωm is interpreted as a slip surface with the type of dry clay. The third trajectory (Figure 1 (C)) is obtained in the first layer with a resistivity value of 50.671 m - 71.5 Ωm interpreted as a weathered layer with a
type of sand clay at a depth between 0.342 meters - 5.41 meters, and a second layer of resistivity 101 Ωm - 202 Ωm is interpreted as a slip surface with the type of clay rock (Dry) to mudrock. Whereas, the fourth track (Figure 1 (D)) is obtained at a resistivity value of 28.0 Ωm - 76.2 Ωm interpreted as a weathered layer with a type of sand clay at a depth of 0.342 meters - 4.40 meters, and a second layer obtained resistivity value of 125.7 Ωm - 208 Ωm is interpreted as a slip surface with the type of clay (Dry) to mudrock.

Based on the results of the study, it was found that the third trajectory has the greatest weathered layer thickness than the other trajectory, but also this trajectory is located on the wall of the slope with a sideways trajectory. As well as having a very deep weathered layer structure at the electrode distance to 32 meters so that it can be interpreted that the potential of soil rolling will easily occur down the slope if there are disturbing factors.

Furthermore, the results of the test of excavation rock found at the study site were used to strengthen the results of the interpretation. The following table 2 presents the results of the test name and rock composition.

| Image of Rocks | Name of Rock | Composition of Rocks |
|---------------|--------------|----------------------|
| ![Image](silt-clays-mudrock.png) | Silt-Clays (Mudrock) | Matrix 100% |
| ![Image](subarkose-sandstone.png) | Subarkose Sandstone | Quartz 35%, Felspar 10%, Fragment 5%, Matrix 50% |
| ![Image](lithic-wacke-sandstone.png) | Lithic Wacke Sandstone | Quartz 25%, Felspar 20%, Fragment 25%, Matrix 30% |

The test results of three rock samples in Table 1 show the presence of several types of rocks found in Ulu Kasok Hill, namely Mudrocks (a mixture of silt and clay [12]), subarkose sandstone, which is sandstone which has a lot of quartz mineral content and has a fine texture, and lithic wacke sandstone, is a rock that has a matrix of 15% - 75% with rock fragments less than 50% [13]. In fact, the situation in the field shows that the help of sand clay and clay (Mudrock) dominates the constituents of the upper part of each track, where clay rocks have low permeability, will become very hard in dry conditions [14].
4. Conclusion
The results showed that the geoelectric method succeeded in interpreting the slip surface and the type of weathered layer in Ulu Kasok Hill, Kampar Regency. Based on the research, it was found that the type of slip surface in the study location was dominated by dry clay to mudrock with a range of resistivity values ranging from 101 Ωm - 208 Ωm. Weathered layer type is soil until the clay sand is found in the depth range of 0.342 meters - 5.41 meters. The highest potential for ground movement is on the third track with the largest weathered layer thickness, so that the potential for ground movement through the slip surface on this track is very large if there are disturbing factors.

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