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Geophysical Study for Discovering The Missing of Lau Ketuken from The Surface at Sulkam Village

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Abstract

Study for the missing lau Ketuken flow has been done in the Sulkam village, Langkat regency, North Sumatera province Indonesia. The search was begun with the use of geo-electric resistivitymeter to identify the subsurface rock structures. The measurement using geo-electric method based on Wenner-Schlumberger configuration. Geo-electric data are processed by using software RES2DINV to show the structure of the subsurface rocks measured. Data bore hole is added as a secondary data to know rock bedding. The outcrops are analyzed using XRD. Then, Match software version 1.9h was applied to knowing the type and nature of mineral rocks and the weight percentage of outcrop rocks. The results show that the subsurface rocks are dominated by sandy clay stones, quartz sand, limestones, and tuffa. The weight percentage of limestones ($CaCO_3$) is 96.5 % in average.

***Keywords*:** geo-electric; resistivity; bore hole; XRD

1. Introduction

Lau Ketuken is a river flow in Kerajen area at Sulkam village, Langkat regency, North Sumatera province Indonesia.

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Lau Ketuken appears in rainy seasons and disappears in dry seasons. This unique feature is interesting to be studied. Geo-electric method is widely used to predict the electrical characteristics of a medium or the formation of subsurface rocks in karst area in order to differentiate clay and carbonate area through resistivity [1,2,3]. The resistivity of rocks and sediment varies from 1 Ωm to 10.000 Ωm [4], depend on saturated level, type of liquid that fulfill the pore and also the percentage of clay. The clay tend to reduce the resistivity because conductivity of clay particles are negatively charge. This makes the resistivity less than 100 Ωm [5]. Meanwhile, the resistivity of Carbonate rocks generally is about 500 Ωm to 10^7 Ωm. It is happened as a result of low porosity as well as interconnection among the pore [6]. On the other hand, detection in earth surface includes measurement of current potential field that happened both naturally and because of current injection inside the earth.

X-ray diffraction method [7] is popularly used to discover the property of rocks. A Research [8] shows there are $CaCO_3$ (calcite) in sample of outcrop rock from Sulkam village using X-ray diffraction method. The research figures that peaks of calcite in 2θ are at 29.42^0, 39.43^0, and 48.53^0. Thus, this research aims for discovering causes of the missing of lau Ketuken by identifying the subsurface structure and the kind of rocks for each layer as well as the characteristics of minerals in lau Ketuken. Geo-electric and X-ray diffraction methods are used in this research. Furthermore, bore hole data is also added.

2. Method of Research

This research was located at lau Ketuken in Kejaren area, at Sulkam village Langkat regency North Sumatera, Indonesia. Its topography is shown in figure 1.

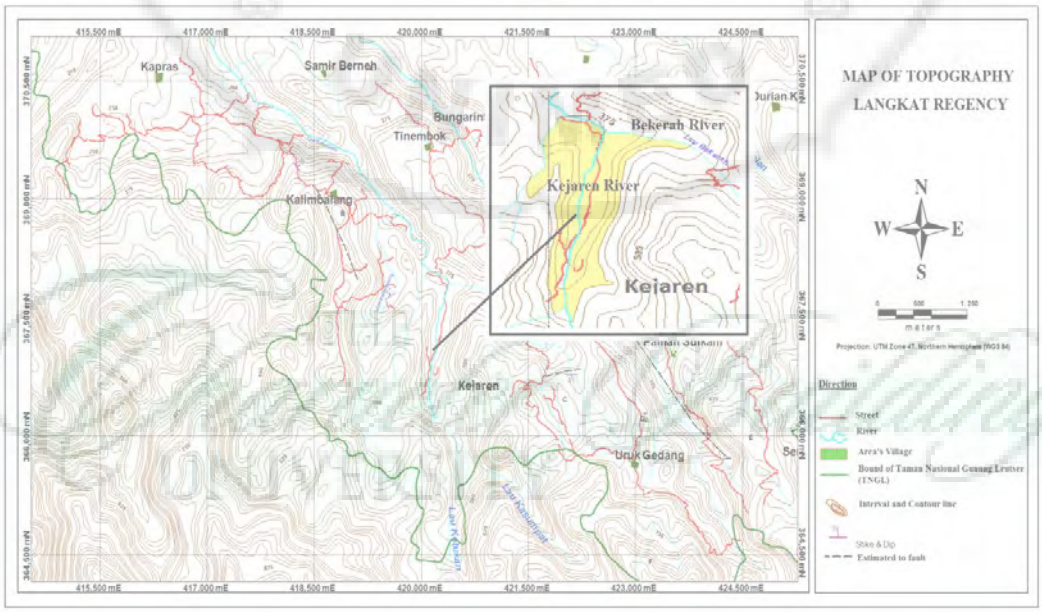


Figure 1: Topography Map of Reseach Area

Data was gain by applying geo-electric method using *Resistivity Meter* model ARES-G4.v47 (*Automatic Resistivity System*) series number SN: 0609135. The trajectory was determined by using compass and *Global*

Position System (GPS) map 76CSx in coordinate UTM. Each of the grid squares is equal to 250 meter x 250 meter with expanse length by 155 meter. There are 15 lines in a trajectory which is each line consist of 32 electrodes. The interval among electrodes is 5 meters. The gridding result of Lau Ketuken (figure 2) shows that it is located in the 340 – 680 meter height above the sea surface.

(a) Lau Ketuken (a) Gridding Result

Figure 2: Research Location

Data from geo-electric ARES was computed using *software* Res2DinV in order to show profile of subsurface area of lau Ketuken. The result was 2D resistivity contour based on modeling inversion (*inverse model resistivity section*). The Data are differentiating according to its color (figure 3).

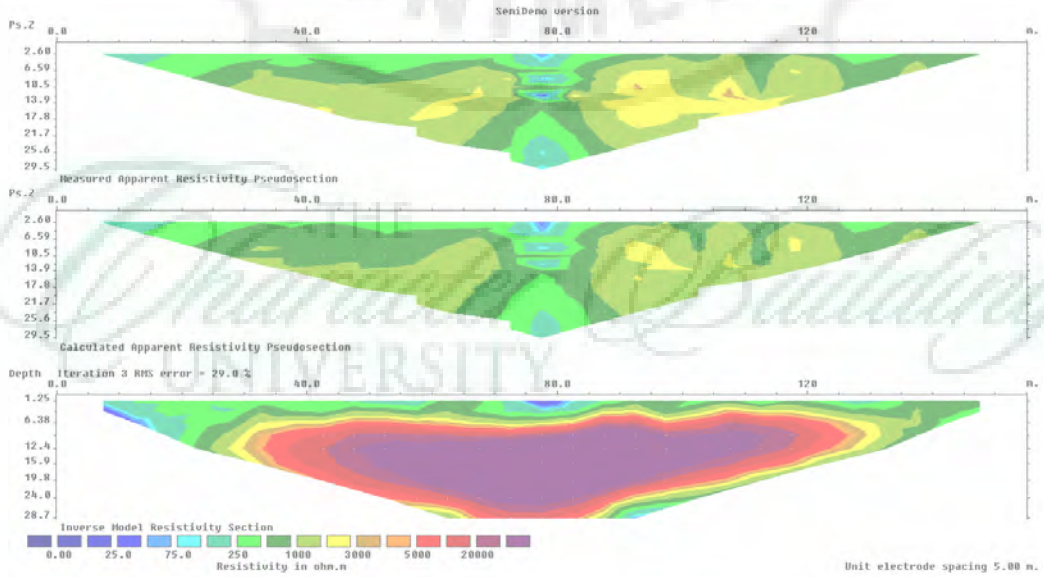


Figure 3: Pseudo-section from *Resistivity meter*

The rock resistivity values of subsurface in lau Ketuken vary. It is influenced by dry, wed, cracked, and liquid

rock condition. It is also affected by the density, the porosity, the size, and the pore shape of rocks. The geology factor, such as the age of rocks, the texture of rock as well as geological process, namely alteration, corrosion, dissolution, and metamorphism [8]. Type of materials for each layer is defined based on rock resistivity, geological condition and bore hole data. For certain type of rocks at the same skin depth have the same resistivity value. Outcrops are analyzed using XRD type ***XRD-6100*** which is supported by *software* PCXRD 6100/7000 Version 7.00. S*oftware* Match version 1.9h is applied to process the data of mineral weight percentage.

3. Research Results

3.1. Analysis geo-electric

Spreading pattern of rock resistivity for subsurface is earned from pseudo section map of resistivity as a result of invers modeling using Res2DinV. Rock resistivity at the cross section of horizontal axis and vertical axis indicates the effective skin depth. Rock resistivity profile is employed for interpreting anomaly data in this research. Resistivity pseud section map of the trajectory is utilized by making literal slices to obtain rock resistivity in lateral direction. The contour of rock resistivity is generated by using *software Surfer-8*. The contours are classified based on its skin depth. The skin depth is focused from 1,25 meter, 5 meter, 10 meter, 15 meter, 20 meter, 25 meter and 30 meter. The contour resistivity (Ωm) is demonstrated by figure 4.

Contour pattern based on invers modeling at figure 4, indicates a high anomaly. This anomaly due to the present of limestone which has resistivity about 500-4.000 Ωm. The resistivity of tuff pyroclastic rocks is about 200-1.000 Ωm. This latest kind of rock is located in Western part of lau Ketuken. This rocks are formed from sedimentation process of Toba eruption [9]. On the other hand, low anomaly is found in the skin depth of 1.25 meter which is the top layer of rocks. Its resistivity is about 0-100 Ωm. Rock types in this skin depth level are dominated by brown and soft sandy clay stone, well sorted clay minerals, as well as dry and wed quartz sand. These were happened as a result of natural process. They are formed physically and chemically from the change of weather which is accrued in rock along the process of digenetic or direct precipitation, such as fracturation dissolution [10].

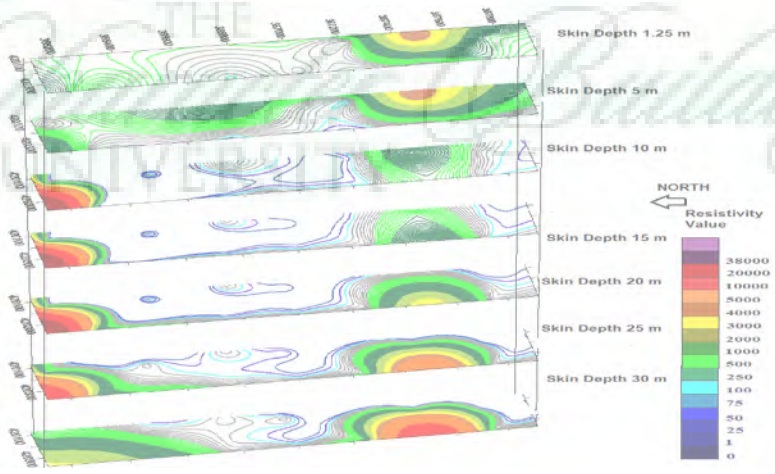
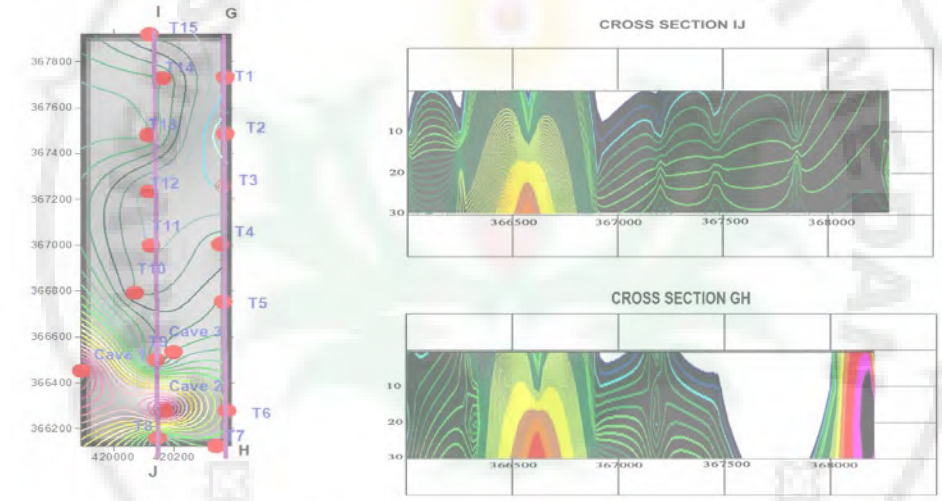


Figure 4: Contour Map of Resistivity Distribution at Skin Depth from 1.25 - 30 Meters in lau Ketuken Flow.

In skin depth level of 2.5 meters to 15 meters, rock layers pretty much turn out of core loss. Namely, in the skin depth of 2.5 meters till 3 meters, then from 4.3 meters to 5 meters, and also between 9 meters and 9.5 meters as well as in the range of 12 – 13.6 meter. According to contour map at figure 4 and bore hole data, rock types in this level are still dominated by brown and soft sandy clay stones, well sorted clay minerals, as well as dry and wed quartz sand. This kind of rocks are high water absorber. The next layers, in skin depth of 15 - 30 meters, black limestone, calcite minerals, calcite vein, spotted calcite crystalline are found. All of these stones are in fresh condition. The limestone is found in the basis and among sandy clay stones. This lime stones absorb water continuously, especially in rainy season. Every drops of the rain consist of carbon CO_2 from the air as well as from the development of organic compounds in the soil. The increasing of carbondioxide causes higher of carbonic acid which is form and accelerate the limestone dissolution.



(a) Altitute surface line IJ and GH (b) Cross section contour

Figure 5: Altitute Surface and Cross Section Contour Along Lau Ketuken

Cutlet vertical across the IJ in the West of lau Ketuken and at GH in the East of lau Ketuken In order to identify the subsurface structure, (figure 5). The vertical slices between IJ and GH shown the litology rocks. There was a limestone at IJ and GH in North and South part of Lau Ketuken. From the cutlet we can see clay that make porous. Porous that form in the middle and from the surface to the 30 meters deep in the GH orbit is a cave that form from natural process there are fracturation and dissolution. Tha fracture process is a mechanism which can produce a fracture and crack at the limestone. Fracture and crack can be produce because of the fault, folding, decompression and decompact or because of erusion that erupted the top layer making a new adjustments on the rocks mechanically, openings on the layer of bedding plane. Through the crack and fracture, the water flow and make the dissolution process on, and enlarge the limestone opening and make the underground surface channel.

Surface channel formed a pores in GH and IJ orbit whics is a cave that according to the society spread to the inside (figure 5). The observation of several caves in the area Kejaren, the existence of the cave under the surface with a small entrance but had a big room inside shown in the figure 6.

Figure 6: The existence of cave in altitute surface area

3.2. X-Ray diffraction

Determining the type of rock is done from rock outcrops obtained using XRD diffraction pattern as in the figure 7 below.

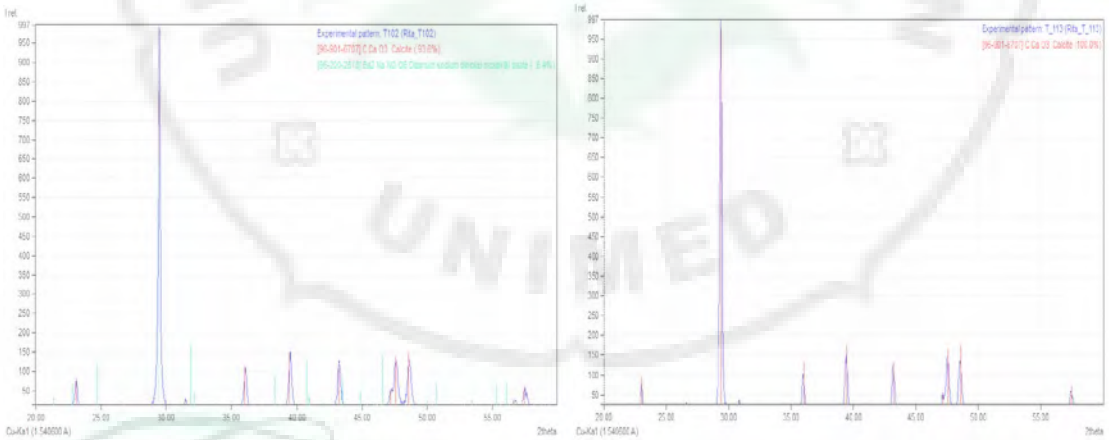


Figure 7: XRD pattern of sample T102 and T113 for outcrop in angle of 2θ

The result of diffraction pattern from XRD in the form of limestone or content $CaCO_3$ (*Calcite)* [7] and $Ba_2NaNi_3O_6$ (*Di-barium sodium di-nickel nickel (III) oxide).* The 2θ peaks of $CaCO_3$ (*Calcite)* are 29.47^0, 36.06^0, 39.50^0, 43.25^0, 47.59^0, 48.60^0 which is equal to COD 96-901-6707. It is a hexagonal crystal with weigh percentage by 93.6 % and 100%. Its density is 2,720 gr/cm^3.

Density is very sensitive to the type of rock forming minerals. Limestone is a sedimentary rock which is rich in quartz and feldspar. It tends to be less dense compared with volcanic rocks. Limestone density increases with the age of rocks and depth. The form of $CaCO_3$ crystal is hexagonal which means it is more stable, usually a good crystal and clear crystal. It is found as a result of recrystallization Aragonite as well as cement filler space between the grains and fractures.

4. Conclusion

1) Subsurface structure of lau Ketukan in Sulkam village – Langkat regency is dominated by sandy clay stone, quartz sand, and limestone. The sandy clay stone is brown and well sorted. Whereas the limestone is at the outcrop and at the river base. There are also tuffs in western part of lau Ketuken.
2) The folded back rocks are predominantly by limestone rocks or $CaCO_3$ which is highly influence the level of water absorbance. This is the prime cause of dryness in the surface of lau Ketuken.

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