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Subsurface analysis of chinese city sites in north sumatra medan marelan subdistrict using geoelectric methods

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Abstract. The area of the Chinese city site is a maritime trading network that entered North Sumatra via the Sumatra Northeast coastline in the 11th to 14th centuries. The Chinese City Heritage site owned by North Sumatra located in Paya Pasir Village, Medan Marelان Subdistrict. Information on the condition and subsurface shape of the site is needed to reveal the existence of the site so that it is easy to excavate and does not damage the surrounding soil. The study aimed to analyze the distribution of Chinese cities below the surface. The research was carried out by using the 6-track Wenner-Schlumberger geoelectric method. Each track used 16 electrodes with an electrode distance of 5 m. The data was processed using Res2DinV and Surfer software. Alluvial layers dominated the results obtained from the subsurface structure. The resistivity of the northern part of the site has a low anomaly starting at 1.25 meters which were the uppermost layer dominated by shallow brackish groundwater that has been intruded. The Chinese city site in the form of temples was found in the southern part at a depth of 1.25 meters to 3.88 meters marked with red bricks filled with water with resistivity 28.9-56.7 Ωm and findings of artifacts around the research location.

1. Introduction

The area of the Chinese city site is a maritime trading network that entered North Sumatra via the Sumatra Northeast coastline in the 11th to 14th centuries. The Chinese City Site is a cultural heritage owned by North Sumatra in Paya Pasir Village, Medan Marelان Subdistrict. The Chinese City Site is located on the peninsula which is a meeting between the Belawan River and Deli River with swampy areas [1]. John Anderson discovered the Chinese city site in 1823, but the sustainability of Chinese city sites is being noticed after 2018.

Preserving the city of China is not an easy job. The city of China as cultural heritage is increasingly pinched by its existence because the location of the Chinese city is increasingly crowded with settlements. Community settlements are built on land under which there are historical heritage sites. This caused a big problem because due to the increase in residential land, the Chinese city site would gradually disappear. The loss of the Chinese city site will cause a loss of cultural heritage that is very valuable for both present and future generations.

Chinese city sites as cultural heritage will be protected if the existence of the site is known with certainty. The existence of sites that are still below the surface is essential to know to save cultural heritage. Knowing that the existence of situ beneath the surface not only makes Chinese city sites protected but can make excavations easier and community settlements can be appropriately arranged.



Relics of ancient sites from the Chinese city which are still buried important in their existence and identified by using methods and measuring instruments that can measure physical parameters associated with the existence of relics of ancient sites. The method used to analyze the remains of ancient sites by knowing the subsurface structure of the City of China site is the geoelectric method.

The geoelectric method is one of the methods in geophysics that studies the nature of electricity in the earth. Surface detection involves measuring potential, current and electromagnetic fields that occur either naturally or as a result of injecting current into the earth. Detection aims to estimate the electrical properties of the medium or rock formations below the surface, especially its ability to conduct or inhibit electric current. Injecting an electric current with a high voltage into the ground is carried out through a current electrode that is plugged into the ground. The flow of electric current will cause an electric potential difference between two points on the ground. The electrical potential difference that occurs is estimated to know the electrical properties of the medium or subsurface rock formations so that it can find sites that are buried through resistivity values [2] [3].

The resistivity values of sites in the form of temple rocks made of clay have varying values [4], depending on the degree of saturation, type of liquid that fills the pore and clay content percent. The clay tends to reduce resistivity because it is conductive along the trajectory of the surface of the clay particle which is negatively charged so that the resistivity is less than 100 Ωm [5].

2. Method

2.1. Research Location

The study was conducted in Paya Pasir Village, Marelan Medan Subdistrict with a topographic map in Figure 1.



Figure 1. Topography Map of Reseach Area

Field data retrieval using the geoelectric method with Resistivity Meter ARES-G4. V47 model (Automatic Resistivity System) serial number SN: 0609135. Determination of the trajectory taken in the area of China City site by using a compass and Global Position System (GPS) map 76CSx in UTM coordinates with the length of 75 meters. The track was taken as many as six tracks. Each path consisted of 16 electrodes with a distance between electrodes of 5 meters (Figure 2).

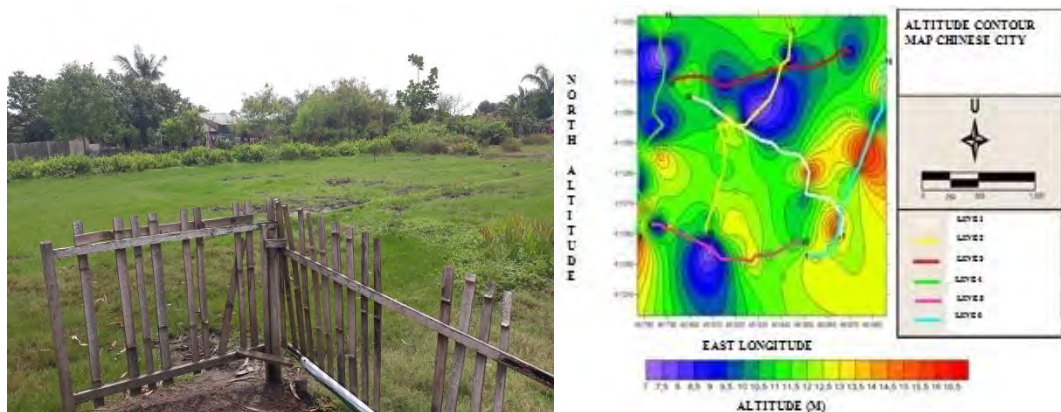


Figure 2. Research Location

The results of the imaging with the coordinate points obtained from the study location 7-16 meters above sea level with a flat topography (Figure 2).

2.2. Method Research

ARES geoelectric data was processed with a computer using the Res2DinV software to show the subsurface profile of the area being measured. The results of data processing with Res2DinV software in 2D form the actual resistivity contours obtained after going through the inversion modeling process (inverse resistivity section). Processed data obtained 2D subsurface images along the path with resistivity values were distinguished by color reading (Figure 3).

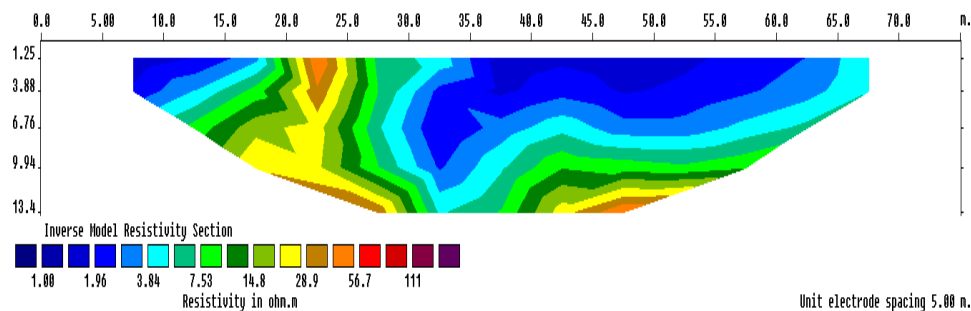


Figure 3. The Result of Resistivity Meter

The subsurface rock resistivity value in the area of the site varies because rock resistivity was determined by dry, wet, cracked, solid and liquid rock conditions. It was influenced by the nature and type of rock including density, porosity, rock pore size and shape, and geological factors namely age rocks, textures, rocks and geological processes which include alteration, weathering, dissolution, and metamorphism [6]. Determination of the type of coating material was determined based on the resistivity value of rock and geological conditions that have many layers of sediment and seawater intrusion in the measurement area.

3. Reseach Result

The pattern of subsurface rock resistivity distribution was obtained from the resistivity pseudosection map resulting from the inversion model with Res2DinV software. The rock resistivity value at the intersection of the horizontal axis with the vertical axis showed effective depth. Rock resistivity cross section was used to analyze subsurface areas for determining rock resistivity anomalies found in the study area. The map results in crossing resistivity measurements by making a lateral incision to obtain rock resistivity in the lateral direction. The rock resistivity contour at each depth was made using the Surfer-8 software. The contour was made by grouping depth for all measurement paths. Measuring trajectories represented the spread of rocks in certain depth. Depth of focus was started at 1.25 meters,

5 meters, 10 meters and 12.5 meters from the result of resistivity (Ωm) of the rock shown in (Figure 4).

The area of the Chinese city site modeling results was analyzed as a whole dominated by low resistivity from 1-120 Ωm . The southern part of the site in the cross section there was a higher anomaly than the surrounding in the form of an alluvial layer which was the result of sediment coming from the gray-brown river color with clay formation with resistivity 1-10 Ωm , sandy clay with resistivity 10-20 Ωm and sand with resistivity 20-70 Ωm [7].

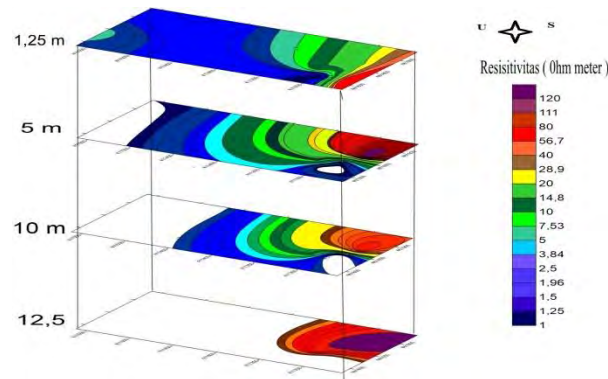


Figure 4. Map of resistivity distribution contours at depths of 1.25, 5, 10 and 12.5 meters

The resistivity of the northern part of the Chinese city site had a low anomaly starting at 1.25 meters which were the uppermost layer dominated by shallow groundwater with salty taste with a resistivity value of 1 Ωm that had been intruded [8]. A depth of 9-10 m consists of layers of freshwater (alluvial) sludge aquifers mixed with sand, gravel and clay sand with resistivity values of 0.691-4.90 Ωm [9]. The existence of intrusion in the area of the Chinese City site was supported by the discovery of a small river that flows into the Belawan river which is widely used for ponds.

The lateral incision in the southern part was seen at a depth of 1.25 meters to 3.88 meters with a resistivity clay layer 28.9-56.7 Ωm which was estimated by a buried temple [10] [11]. The clay layer anomaly strengthened the lateral incision on one of the trajectories, which was the path 3 (Figure 5). The existence of the temple was marked by the presence of outcrops in the form of red bricks in wet conditions (Figure 6). The red brick that forms the temple on the site of the City of China which was made of a mixture of clay and water had a pore that was able to absorb water around it causing a decrease in resistivity value. The red brick forming the temple on the site of the City of China had in common with the temple buildings located in Padang Lawas.

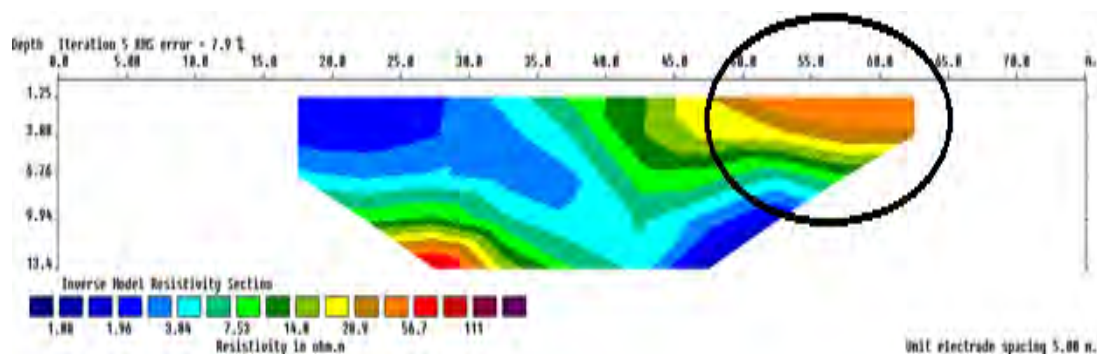


Figure 5. The result of geoelectric measurement on track three



Figure 6. The existence of sites in the Chinese City area

The subsurface analysis of Chinese City sites based on resistivity values for depths of 1.25 meters to 12.5 meters is shown in Table 1.

Table 1. Resistivity of Chinese City Site Coatings

No.	Depth (m)	Resistivity (Ω m)	Colour	Interpretation of Coating Types
1	1.25	1-60		Alluvial containing water
2	5	1-111		Alluvium, Alluvial which contains water and gravel sand
3	10	2- 60		Water, clay
4	12.5	30-111		Alluvium, clay, sand, gravel

Based on Table 1 the resistivity values of the coating of Chinese city sites consist of alluvial layers which are sedimentary layers, formed from fine mud and sand from the alluvium layer which undergoes weathering. The sedimentation process that forms the terrain is the result of the deposition of material carried by the Belawan and Deli rivers. The Belawan River and the Deli River are classified as perennial rivers where rivers are filled with water throughout the year.

The research area of the Chinese City site had found artifacts, pottery, and beads which archeologists analyzed from the 11-13th century AD [1]. It can be seen in Figure 7 :



Figure 7. Artifact findings in areas of the Chinese City site

Historical relics in the form of temples, artificial objects (artifacts) and beads in the city of Medan, China in figure 7 are historical collections that can be used for the benefit of science and development of history so that the government attention and concern of the surrounding community to maintain, care and preserve historical heritage.

4. Conclusion

The results of data processing and interpretation were obtained that alluvial layers dominated the subsurface structure of the Chinese City site. The resistivity of the northern part had a low anomaly starting at 1.25 meters which were the uppermost layer dominated by shallow brackish groundwater that had been intruded. The alluvial layer of sediment from Belawan and Deli rivers was gray-brown with clay formation, sandstone clay, and sand. The Chinese city site in the form of temples was found in the southern part at a depth of 1.25 meters to 3.88 meters marked with red bricks filled with water with resistivity 28.9-56.7 Ωm and findings of artifacts around the research location.

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