Near-Surfaces Geophysics Application for Archaeology, Coal Mining and Road Landslide in East Kalimantan Province of Indonesia

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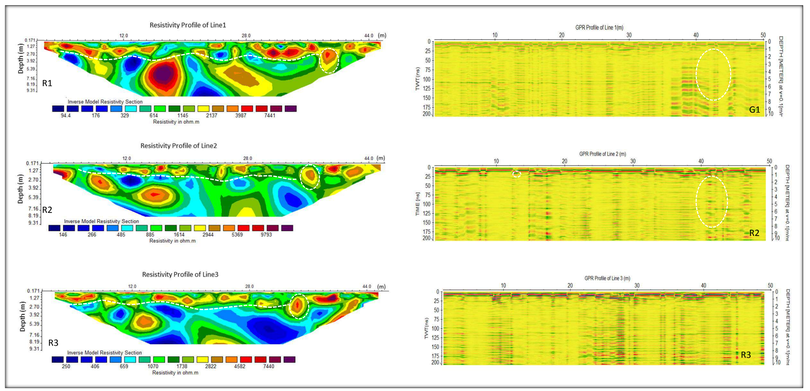
Application of NSG in Archaeological Site

The Oldest Hindu Kingdom in Indonesia:

A combined method of Near-Surface Geophysical (NSG) survey was conducted in an archaeological site of the historical region of the kingdom of Kutai Mulawarman situated in Muara Kaman district, East Kalimantan province of Indonesia. The Kutai is the place of the first and the oldest Hindu Kingdom in Indonesia, indicated by the yupa inscription dated about the 5th century AD. This is the preliminary study and assumes to be the first geophysical study conducted on this historical site. The geophysical survey deployed magnetometer, Electrical Resistivity Tomography (ERT), and Ground Penetrating Radar (GPR), the three main methods that are commonly used for archaeological study. The deployed geophysical measurements in four designated sites, but I displayed the following data only from the sector of Candi A.

ERT and GPR Profiles:

The reconnaissance survey using ERT and GPR methods acquired the data in three lines survey. Field measurement used MAE Resistivity meter of 48 electrodes and AKULA-Geoscanner of 100 MHz. The survey strategy was planning to map the soil stratigraphy and possible to detect the small artifact of the man-made object. Resistivity profile R1-R3 in general is divided into two layers. The top layer is unconsolidated material indicated with truncated high resistivity and thickness less than 3 meters. The investigation area was illegally digging up and sporadically for economic purposes, and finding artifacts was selling to the antique collectors. The main image in GPR G1-G3 and coincide with ERT result showing the concave reflection that interprets to be associated with a fortress or ditch. Several diffraction patterns in GPR profile interpret as small artifacts like ceramic, firing pitch.



Application of NSG in Coal Mining Industry

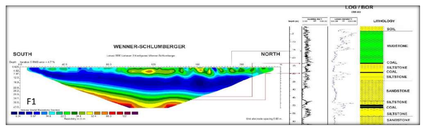
Coal Mining in Kutai Basin:

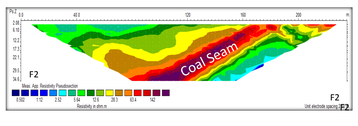
The Tertiary Kutai Basin in East Kalimantan province in Indonesia hosts approximately one-third of the national total coal resources and reserves (MEMR, 2017). The basin is one of the most economical basins in Indonesia that produces hydrocarbon and coal since more than a century ago. Currently, coal exploration still relies mainly on drilling exploration. New technology has to accommodate and disseminate in the coal industry. New geophysical instruments and processing technologies help provide new insights into geology imaging and improved rapid mapping of the subsurface. Geophysical exploration techniques such as resistivity and seismic tomographic imaging technology have a wide application prospect including in coal industries.

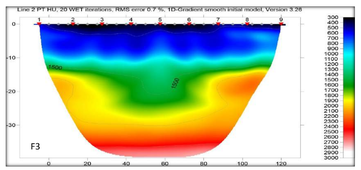
ERT and SRT Profiles:

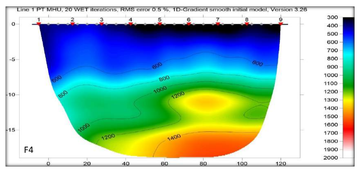
The Electrical Resistivity Tomography (ERT) profile of F1, showing lithology of mudstone with resistivity value <10 Ωm. Two thin coal seams at the depth of 24m and 30 m can be imaged with the resistivity value of 24 Ωm and 34 Ωm respectively. The dip angle of the strata in this area is around 10 degree to the E-W dip direction. F2 reveals the resistivity of the coal seam exposed in the wall on active coal mining. We recommend the ERT method for the sub-crop of the coal seam. ERT profiling working well on shallow coal seam indicated by relatively high resistivity and dip angle of the strata.

F3 and F4 Showing the profiles of Seismic Refraction Tomography (SRT) for imaging soft or hard rock material by measuring the velocity of refracted seismic waves in coal mining. The SRT profiles are divided into four lithologies based on the contour-velocity: top soil-very soft material (300-400)m/s, clay-wet soil (400-800)m/s, compact soil-clayey sandstone (800-1200)m/s, and hard clay >1200 m/s.









Application of NSG in Public Road Landslide

Public Road Landslide

The research and application of the geophysics for geotechnical and environmental surveys are relatively new in our place and it's projected to grow in accordance to the needs of subsurface knowledge for civil engineering constructions and for subsurface environmental studies. The area of study is located in Tenggarong road in the Northwest of Samarinda. The road is mainly allocated for people transportation and trucks for mobilization of goods. The road is relatively new, it's constructed around 2013 but some part has been damaged due to less maintenance and uncontrolled of drainage systems. Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR) were conducted in the two locations on landslide sedimentary rocks in order to understand the triggering processes and mechanism of landslide and subsidence and to assess the soil movement.

ERT and GPR Profiles:

Two geophysical types of equipment have been applied for these study namely MAE X-612EM multi-channel resistivity meter and AKULA 9000 Ground Penetrating Radar (GPR) 100 MHz. The resistivity meter measures the resistivity value of soil that strongly influence by water content and rock lithology. In general the higher the clay content the lower the resistivity value. The GPR method uses to identify the structural geology such as fault, fracture, void or local defects of the road and the thickness of the strata.

L1 and L2 showing the resistivity and GPR profiles in the Jonggon1 Area.The resistivity shows that the slip surface is inferred as the contact between clay-low resistivity (<100 Ωm) and sandy-clay with resistivity > 100 Ωm. Truncated GPR reflection on clay layer interpreted as fractured or shallow fault zone. L3 and L4 showing the resistivity and GPR profiles in the Jonggon2 Area. The slip surface in the second area occurred on the contact between saturated clay with resistivity <10 Ωm and relative dry clay with resistivity >10 Ωm, ERT and GPR data show landslides are characterized by the deformation of the rocks caused by the saturation of the soil and crack-affected water infiltration under rainfall conditions.