

PROCEEDINGS



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**"Sustainable Development in Developing
Country for Facing Industrial Revolution 4.0"**

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Foreword: In the name of Allah, Most Gracious, Most Merciful Assalamu'alaikum Wr. Wb., Welcome to the Second International Conference on Science Engineering and Technology (ICoSET 2019). The advancement of today's computing technology, science, engineering and industrial revolution 4.0 play a big role in the sustainable development of social, economic, education, and humanity in developing countries. Institute of higher education is one of many parties that need to be involved in the process. Academicians and researchers should promote the concept of sustainable development. The Second International Conference on Science,

Engineering and Technology (ICoSET 2019) is organized to gather researchers to disseminate their relevant work on science, engineering and technology. The conference is co-located with The Second International Conference on Social, Economy, Education, and Humanity (ICoSEEH 2019) at SKA Co-EX Pekanbaru Riau. I would like to express my hearty gratitude to all participants for coming, sharing, and presenting your research at this joint conference. There is a total of 84 manuscripts submitted to ICoSET 2019. However only high-quality selected papers are accepted to be presented in this event, with the acceptance rates of ICoSET 2019 is 70%. We are very grateful to all steering committees and both international and local reviewers for their valuable work. I would like to give a compliment to all co-organizers, publisher, and sponsors for their incredible supports. Organizing such prestigious conferences was very challenging and it would be impossible to be held without the hard work of the program committee and organizing committee members. I would like to express my sincere gratitude to all committees and volunteers from Singapore Management University, Kyoto University, Kyushu University, University of Tsukuba, Khon Kaen University, Ho Chi Minh City University of Technology, University of Suffolk, Universiti Teknologi Malaysia, Infrastructure University Kuala Lumpur, Universiti Malaya, Universiti Kebangsaan Malaysia, Universiti Utara Malaysia, Universiti Teknologi Mara, and Universiti Pendidikan Indonesia for providing us with so much support, advice, and assistance on all aspects of the conference. We do hope that this event will encourage collaboration among us now and in the future. We wish you all find the opportunity to get rewarding technical programs, intellectual inspiration, and extended networking. Pekanbaru, 27th August 2019 Dr. Arbi Haza Nasution, M.IT Chair of ICoSET 2019

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Papers

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Show

All 

papers

Design of Community-based Ecotourism at Cengkehan and Giriloyo, Wukirsari Village, Imogiri District, Bantul Regency, Special Region of Yogyakarta

P. 5 - 10

Suhartono , Sri Mulyaningsih , Desi Kiswiranti , Sukirman , Nurwidi A. A. T. Heriyadi , Muchlis and Iva Mindhayani

DOI:10.5220/000900390

Prototype Storage Locker Security System based on Fingerprint and RFID Technology

P. 11 - 14

Apri Siswanto , Hendra Gunawan and Rafiq Sanjaya

DOI:10.5220/000906290

Feasibility Study of CO2 Flooding under Gross-split Mechanism: Simulation Approach

P. 15 - 19

Muslim Abdurrahman , Wisup Bae , Adi Novriansyah , Dadan Damayandri and Bop Duana Afrireksa

DOI:10.5220/000906320

Online Classroom Attendance System based on Cloud Computing

P. 20 - 25

Sri Listia Rosa and Evizal Abdul Kadir

DOI:10.5220/000906390

-
- Analysis of Porosity and Permeability on Channel Deposit Sandstone using Pore-gas Injection and Point Counting in Sarilamak Area, West Sumatra** P. 26 - 30
Bayu Defitra , Tiggi Choanji and Yuniarti Yuskar DOI:10.5220/000906470
-
- A Simulation Study of Downhole Water Sink Guidelines Plot Application using Real Field Data** P. 31 - 34
Praditya Nugraha DOI:10.5220/000906550
-
- Groundwater Exploration using 2D Electrical Resistivity Imaging (ERI) at Kulim, Kedah, Malaysia** P. 35 - 40
Adi Suryadi , Muhammad Habibi , Batara , Dewandra Bagus Eka Putra and Husnul Kausarian DOI:10.5220/000906560
-
- Risk Identification in Management System Process Integration Which Have Impact on the Goal of Management System Components** P. 41 - 48
Nastasia Ester Siahaan , Leni Sagita and Yusuf Latief DOI:10.5220/000909140
-
- The Performance of 3D Multi-slice Branched Surface Reconstruction on CPU-GPU Platform** P. 49 - 54
Normi Abdul Hadi and Norma Alias DOI:10.5220/000909270
-
- Tile-based Game Plugin for Unity Engine** P. 55 - 63
Salhazan Nasution , Arbi Haza Nasution and Arif Lukman Hakim DOI:10.5220/000910370
-
- Image Segmentation of Nucleus Breast Cancer using Digital Image Processing** P. 64 - 67
Ana Yulianti , Ause Labellapansa , Evizal Abdul Kadir , Mohana Sundaram and Mahmud Othman DOI:10.5220/000910590
-
- An Integrated Framework for Social Contribution of Diabetes Self-care Management Application** P. 68 - 73
Zul Indra , Liza Trisnawati and Luluk Elvitaria DOI:10.5220/000910610
-
- Spatiotemporal Analysis of Urban Land Cover: Case Study - Pekanbaru City, Indonesia** P. 74 - 79
Idham Nugraha , Faizan Dalilla , Mira Hafizhah Tanjung , Rizky Ardiansyah and M. Iqbal Hisyam DOI:10.5220/000910630
-
- The Effectiveness of Rice Husk Biochar Application to Metsulfuron Methyl Persistence** P. 80 - 84
Subhan Arridho , Saripah Ulpah and Tengku Edy Sabli DOI:10.5220/000911960
-
- Digital Forensics: Acquisition and Analysis on CCTV Digital Evidence using Static Forensic Method based on ISO /IEC 27037:2014** P. 85 - 89
Rizdqi Akbar Ramadhan , Desti Mualfah and Dedy Hariyadi DOI:10.5220/000912040

Testing the Role of Fish Consumption Intention as Mediator	P. 90 - 97
Junaidi , Desi Ilona , Zaitul and Harfiandri Damanhuri	DOI:10.5220/000912060
Segmentation of Palm Oil Leaf Disease using Zoning Feature Extraction	P. 98 - 101
Ause Labellapansa , Ana Yulianti and Agus Yuliani	DOI:10.5220/000912210
Analysis of Economy in the Improvement of Oil Production using Hydraulic Pumping Unit in X Field	P. 102 - 108
Muhammad Ariyon , Novia Rita and Tribowo Setiawan	DOI:10.5220/000912940
Construction Design and Performance of Dry Leaf Shredder with Vertical Rotation for Compost Fertilizer	P. 109 - 113
Syawaldi	DOI:10.5220/000912960
The Impact of Additively Coal Fly Ash toward Compressive Strength and Shear Bond Strength in Drilling Cement G Class	P. 114 - 119
Novrianti , Dori Winaldi and Muhammad Ridho Efras	DOI:10.5220/000912980
Impact of Vibration of Piling Hammer on Soil Deformation: Study Case in Highway Construction Section 5 Pekanbaru-Dumai	P. 120 - 124
Firman Syarif , Husnul Kausarian and Dewandra Bagus Eka Putra	DOI:10.5220/000912990
Combination Playfair Cipher Algorithm and LSB Steganography for Data Text Protection	P. 125 - 129
Apri Siswanto , Sri Wahyuni and Yudhi Arta	DOI:10.5220/000914450
Fire Detection System in Peatland Area using LoRa WAN Communication	P. 130 - 134
Evizal Abdul Kadir , Hitoshi Irie and Sri Listia Rosa	DOI:10.5220/000914510
Forest Fire Monitoring System using WSNs Technology	P. 135 - 139
Evizal Abdul Kadir , Sri Listia Rosa and Mahmud Othman	DOI:10.5220/000914520
Multi Parameter of WSNs Sensor Node for River Water Pollution Monitoring System (Siak River, Riau-Indonesia)	P. 140 - 145
Evizal Abdul Kadir , Abdul Syukur , Bahruddin Saad and Sri Listia Rosa	DOI:10.5220/000914530
Analysis for Gerund Entity Anomalies in Data Modeling	P. 146 - 150
Des Suryani , Yudhi Arta and Erdisna	DOI:10.5220/000914560
The Incidence of Rhinoceros Beetle Outbreak in Public Coconut Plantation in Tanjung Simpang Village, Indragiri Hilir, Riau Province	P. 151 - 154

Mobile Application of Religious Activities for the Great Mosque Islamic Center Rokan Hulu with Push Notification P. 155 - 162

Salhazan Nasution , Arbi Haza Nasution and Fitra Yamita

DOI:10.5220/000914590

An Augmented Reality Machine Translation Agent P. 163 - 168

Arbi Haza Nasution , Yoze Rizki , Salhazan Nasution and Rafi Muhammad

DOI:10.5220/000914630

The Community Perception of Traditional Market Services in Pekanbaru City, Riau Province P. 169 - 174

Puji Astuti , Syaifullah Rosadi , Febby Asteriani , Eka Surya Pratiwi and Thalia Amanda Putri

DOI:10.5220/000914650

Separation of Crude Oil and Its Derivatives Spilled in Seawater by using Cobalt Ferrite Oxide P. 175 - 181

Mohammed A, Samba , Ibrahim Ali Amar , Musa Abuadabba , Mohammed A. Alfroji , Zainab M. Salih and Tomi Erfando

DOI:10.5220/000914690

Study of Open Space Utilization in Pekanbaru City, Riau Province P. 182 - 187

Mira Hafizhah T. , Febby Asteriani , Mardianto and Angelina Rulan S.

DOI:10.5220/000914910

Application of Augmented Reality as a Multimedia Learning Media: Case Study of Videography P. 188 - 193

Ahmad Zamsuri , Fadli Suandi and Rizki Novendra

DOI:10.5220/000914920

Green Building Performance Analysis in the Stimi Campus Building P. 194 - 199

Dian Febrianti and Samsunan

DOI:10.5220/000914930

Towing Service Ordering System based on Android: Study Case - Department of Transportation, Pekanbaru P. 200 - 204

Panji Rachmat Setiawan , Yudhi Arta and Rendi Sutisna

DOI:10.5220/000915000

Biosurvey of Mercury (Hg), Cadmium (Cd), and Lead (Pb) Contamination in Reclamation Island-Jakarta Bay P. 205 - 210

Salmita Salman , Achmad Sjarmidi and Salman

DOI:10.5220/000915120

Expert System to Detect Early Depression in Adolescents using DASS 42 P. 211 - 218

Nesi Syafitri , Yudhi Arta , Apri Siswanto and Sonya Parlina Rizki

DOI:10.5220/000915820

Geotechnics Analysis: Soil Hardness on Stability of Davit Kecil's Weir in Ulu Maras, Kepulauan Anambas, Kepulauan Riau P. 219 - 228

Support for Heritage Tourism Development: The Case of Ombilin Coal Mining Heritage of Sawahlunto, Indonesia P. 229 -
236

Jonny Wongso , Desi Ilona , Zaitul and Bahrul Anif

DOI:10.5220/000918540

Aerial Photogrammetry and Object-based Image Analysis for Bridge Mapping: A Case Study on Bintan Bridge, Riau Islands, Indonesia P. 237 -
242

Husnul Kausarian , Muhammad Zainuddin Lubis , Primawati , Dewandra
Bagus Eka Putra , Adi Suryadi and Batara

DOI:10.5220/000918580

Monitoring Single Site Verification (SSV) System and Optimization BTS Network based on Android P. 243 -
249

Abdul Syukur , Siti Rahmadhani Sabri and Yudhi Arta

DOI:10.5220/000918610

Characterization of the Ethnobotany of Riau Province Mascot Flora (Oncosperma tigillarum (Jack) Ridl.) P. 250 -
253

Desti , Fitmawati , Putri Ade Rahma Yulis and Mayta Novaliza Isda

DOI:10.5220/000918620

Effect Stocking Density on Growth and Survival rate of Larval Selais Fish (Kryptopterus lais) Cultured in Recirculation System P. 254 -
257

Agusnimar Muchtar and Rosyadi

DOI:10.5220/000918630

Development of Safety Plan to Improve OHS (Occupational Health and Safety) Performance for Construction of Dam Supporting Infrastructure based on WBS (Work Breakdown Structure) P. 258 -
267

Aprilia Dhiya Ulhaq , Yusuf Latief and Rossy Armynt Machfudiyanto

DOI:10.5220/000918650

Design of Web Login Security System using ElGamal Cryptography P. 268 -
273

Yudhi Arta , Hendra Pratama , Apri Siswanto , Abdul Syukur and Panji
Rachmat Setiawan

DOI:10.5220/000918680

Standard Operational Procedures Development for Government Building's Care and Maintenance Work of Outer Spatial and Housekeeping Component to Improve Work Effectiveness and Efficiency using Risk-based Approach P. 274 -
284

Lasita Khaerani , Yusuf Latief and Rossy Armynt Machfudiyanto

DOI:10.5220/000918720

A Novel Correlation on MMP Prediction in CO₂-LPG Injection System: A Case Study of Field X in Indonesia P. 285 -
290

Prasandi Abdul Aziz , Hendra Dwimax , Tutuka Ariadji , Steven Chandra ,
Wijoyo Niti Daton and Ressi Bonti

DOI:10.5220/000935980

Productivity Analysis of Frac-pack Completion in M Well with Sand Problem Indication and High Permeability Formation P. 291 -
298

Herianto , Prasandi Abdul Aziz , Wijoyo Niti Daton and Steven Chandra

DOI:10.5220/000935990

Emulsion Treatment using Local Demulsifier from Palm Oil	P. 299 - 303
Tomi Erfando and Emre Fathan	DOI:10.5220/000936010
Designing an IoT Framework for High Valued Crops Farming	P. 304 - 310
Domingo Junior P. Ngipol and Thelma D. Palaoag	DOI:10.5220/000936450
Consideration of the Different Pile Length Due to Soil Stress and Inner Forces of the Nailed-slab Pavement System under Concentric Load	P. 311 - 314
Anas Puri , Roza Mildawati and Muhammad Solihin	DOI:10.5220/000936490
Utilization of Agricultural Waste to Be Bioethanol Sources as a Solvent on Paraffin Wax Crude Oil Issues	P. 315 - 321
M. K. Afdhol , F. Hidayat , M. Abdurrahman , H. Z. Lubis , R. K. Wijaya and N. P. Sari	DOI:10.5220/000936690
The Effect of Regeneration Time of Biomass Activated Carbon using Low Temperature to Reduce Filtration Loss in Water-based Drilling Fluid	P. 322 - 325
Nur Hadziqoh , Mursyidah , Arif Rahmadani , Idham Khalid and Hasnah Binti Mohd Zaid	DOI:10.5220/000938550
Improving the Accuracy of Features Weighted k-Nearest Neighbor using Distance Weight	P. 326 - 330
K. U. Syaliman , Ause Labellapansa and Ana Yulianti	DOI:10.5220/000939090
Predicting of Oil Water Contact Level using Material Balance Modeling of a Multi-tank Reservoir	P. 331 - 336
Muslim Abdurrahman , Bop Duana Afrireksa , Hyundon Shin and Adi Novriansyah	DOI:10.5220/000940460
Chip Formation and Shear Plane Angle Analysis on Carbon Steel Drilling using Solid Carbide Tools	P. 337 - 341
Rieza Zulrian Aldio	DOI:10.5220/000940620
A Solution to Increase Natuna D Alpha's Resource Utilization by Cryogenic Distillation: Conceptual Design & Sensitivity Study	P. 342 - 348
Wijoyo Niti Daton , Ezra Revolin , Siptian Nugrahawan , Prasandi Abdul Aziz , Tutuka Ariadji , Steven Chandra and J. A. Nainggolan	DOI:10.5220/000942720
Design of Volcanic Educational-based Natural Tourism at Giriloyo, Wukirsari Village, Imogiri District, Bantul Regency, Yogyakarta-Indonesia	P. 349 - 356
Sri Mulyaningsih	DOI:10.5220/000943570
Four Types of Moral Holistic Values for Revolutionizing the Big Data Analytics in IoT-based Applications	P. 357 - 362



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Groundwater Exploration using 2D Electrical Resistivity Imaging (ERI) at Kulim, Kedah, Malaysia

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Keywords: 2D Electrical Resistivity Imaging (ERI), Dipole-Dipole, Groundwater, Resistivity, Kulim, Malaysia

Abstract: Water demand in the study area has been increasing by time but surface water is not sufficient to fulfil the demands. 2D Electrical Resistivity Imaging (ERI) survey was conducted in order to looking for groundwater potential as freshwater alternative resources at Kulim, Kedah, Malaysia. The data acquisition was carried out using 5 meters multi-electrodes spacing with pole-dipole configuration array. The geophysical survey involved both resistivity and chargeability at the same time. The result of 2D Electrical Resistivity Imaging indicated that the groundwater potential area has low resistivity value with range 10 – 100 Ω m. Groundwater potential zone divided into 2 characteristics which is shallow groundwater zone (>75m in depth) and deep groundwater zone (>100m in depth). The groundwater potential zone covered by high to very high resistivity value. Those high resistivity value 200 – 1000 Ω m interpreted as dry top soil at near surface while at deep zone is interpreted as fresh bedrock. Chargeability value of groundwater potential area ranging from 0 up to 8 msec. All interpretation later confirmed by drilling data.

1 INTRODUCTION

Geo-electrical survey is a survey that looking the physical parameters which is resistivity value to differentiate subsurface material. Recently, the interest of underground sources of water is increasing rapidly to fulfilled the water demand (A Suryadi et al., 2019). Electrical Resistivity Imaging (ERI) is the most common and successfully used especially in groundwater exploration and environmental problems (Azhar et al., 2016; Hamzah et al., 2008; Hamzah et al., 2007; Jumary et al., 2002; Saad et al., 2012). By using ERI, resistivity distribution of subsurface will be modelled into two-dimensional image (A Suryadi et al., 2019). The model that resulted is showing the apparent resistivity value which can be interpret depend on the value.

The study area is located at Silterra Malaysia SdnBhd at Lot 8 and 9 in Kulim, Kedah, Malaysia with coordinate N 5024' 18.24" and E100035' 33.09". The shortage of piped water supply at headquarters Silterra has caused considerable problems to several activities of the central area. The supply of water to the central area is insufficient due to high demand of water. Long period of dry season also affected

to hydrogeology cycle. This water problem is not only caused problem to the factory but it also affected the nearby residential area (Adi Suryadi et al., 2019). So, aim of this study is to locate and delineate groundwater potential zone as alternative water resources at study area.

The area is located about 10 km from Pekan Kulim and about 3 km from Sungai Jarak. Secondary forest and palm oil plantation are covered the study area with almost flat topography (Figure 1). It easily to reach the location by using a car. Nine (9) lines of 2D Electrical Resistivity Imaging (ERI) survey were conducted with length of survey line up to 400 m (Figure 2).

2 GEOLOGICAL SETTING OF STUDY AREA

Geology of Study area is consist of granite and surround by metamorphic rock (slate, phyllite and schist) and sedimentary rock (sandstone, siltstone and shale) (Figure 3). Granite of study area known as Kulim granite that consist of two main types, namely

medium to coarse grained biotite granite and the sparsely porphyritic micro-granite. Both of them are almost similar in mineral content except the former also contains traces of galena, pyrite and garnet. The essential minerals in the granite are K-feldspar, plagioclase, quartz, biotite and muscovite. K-Ar mineral ages for biotite separates from pink porphyritic Penanti granites (north of Bukit Mertajam) defined an age of 196 ± 8 Ma. K-Ar mineral ages for biotite and muscovite separates from the Karangan biotite granite (northeast Kulim) gave an age of 190 ± 10 and 180 ± 10 Ma respectively (Hutchison, 1989).

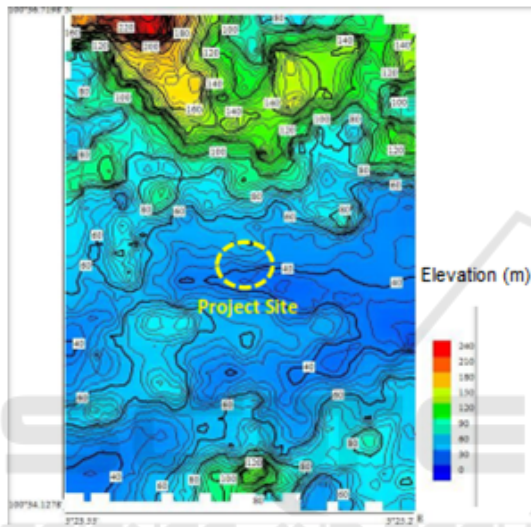


Figure 1: Topography map that shows the location of the study area, which is almost flat.



Figure 2: Satellite image of the study area showing the line survey location.

3 METHODOLOGY

ABEM SAS1000 resistivity meter and ABEM Lund ES464 selector system is the equipment that was used



Figure 3: Geological Map of the study area, which consists of granite and is surrounded by sedimentary rock and metamorphic rock (Hutchison, 1989).

to collect the resistivity data. The survey employed 61 multi-electrodes with a 5 m minimum electrode spacing. The line survey length is 400 m, arranged in a straight line. The selector system was connected to all electrodes through a multi-core cable (Figure 4) (Loke and Barker, 1995) (Azhar et al., 2016; Hamzah et al., 2008; Loke and Barker, 1995; A Suryadi et al., 2019). In each measurement, the resistivity meter only selects four electrodes to activate. Besides that, the coordinates of the line survey must be recorded to correlate all the lines taken (Kausarian et al., 2018, 2016; Lubis et al., n.d.; LUBIS et al., 2018; Suryadi, 2016).

Apparent resistivity (ρ_a) is calculated by multiplying the geometry factor (k) with Voltage (V) and dividing by Current (I) injected.

$$\rho_a = kV/I \quad (1)$$

The geometry factor (k) depends on the electrode configuration used. In this study, the configuration used is the pole-dipole (Figure 5), where k is calculated with the following formula:

$$k = 2\pi(b(a+b))/a \quad (2)$$

a is the distance from P1 to P2; b is the distance from C1 to P1

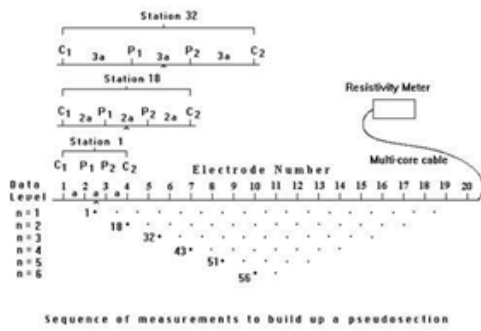


Figure 4: Equipment set up to acquisition resistivity data(Loke and Barker, 1995)

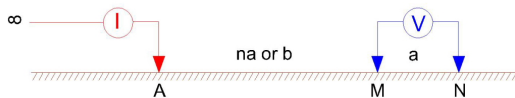


Figure 5: Equipment set up to acquisition resistivity data(Loke and Barker, 1995)

The data collected processed by using inverse modelling software which is RES2DINV. The result of inverse modelling will interpreted based on apparent resistivity and proven by drilling data.

4 RESULT AND DISCUSSION

Nine (9) ERI lines survey data has been processed in order to produce 2D inversion model of resistivity. The resistivity value representing the subsurface condition of study area. There are two typical of groundwater potential zone in this study which are deep groundwater potential and shallow groundwater potential.

Figure 6 is the result of line 6 show the typical 2D ERI result of study area with deep groundwater potential. Generally, resistivity value can be grouped into 3 layers or zones. First zone with moderate to high resistivity value (100 – 1000 Ωm) that represented by colour orange to purple near surface is interpreted as top soil. Usually soil always showing moderate to low resistivity value because it has high moisturized due to subtropical area(N. Nwankwo and O. Emujakporue, 2012; A Suryadi et al., 2019). But in this study top soil showing high resistivity value, this value indicating the condition of soil is dry. Below top soil, resistivity value is extremely high represented by red to dark purple in colour with resistivity range 300 to 2000 Ωm. this layer is interpreted as fresh bedrock layer. Based on geology regional of study area, bedrock of the site is consist

of granite. The third layer is located about 100 m in depth from surface with low resistivity profile (10 – 100 Ωm). This layer showed by bright green to yellow in colour. From those resistivity value, the third layer is interpreted as groundwater potential area because water saturated zone are conductive zone that easily to transfer electrical current. From the result of chargeability also support the interpretation with showing low chargeability (2 – 20 msec).

Another typical of groundwater potential zones is representing by result of line survey 7 (Figure 7). This result also divide into 3 layer. The first layer is dry top soil layer with resistivity value range (100 – 1000 Ωm), followed by very high resistivity value (300 – 2000 Ωm) that interpreted as granite fresh bedrock. In granite zone there is an anomaly resistivity value with coning shape at depth 25 to 75 m. This zone has low resistivity profile which is 3 – 100 Ωm interpreted as shallow groundwater potential. It also linear with chargeability result that showing low chargeability value 2 – 8 msec. Table 1 showing all the groundwater potential zone from 9 survey lines.

From the result of 2D Electrical Resistivity Imaging (ERI), some location that has groundwater potential has been drilled to prove either it actually water saturated zone or not. Besides that, drilling data also proven for all geological interpretation based on resistivity value. Table 2 is drilling location coordinate according to groundwater potential zones that has been interpreted.

Table 1: Groundwater potential zone characteristic and location based on 2D ERI

Survey line	Groundwater potential zone			
	Resistivity (Ωm)	Chargeability (msec)	Depth (m)	Location from 1 st electrode (m)
Line 1	8 - 110	0 - 2	75 - 125	80 - 180
Line 2	10 - 100	8 - 12	125	225 - 255
Line 3	2 - 100	2 - 5	75 - 150	80 - 210
Line 4	3 - 100	1 - 5	75 - 125	140 - 265
Line 5	20 - 100	0 - 1	125 - 150	150 - 230
Line 6	10 - 100	2 - 12	100 - 125	140 - 240
Line 7	1 - 100	0.5 - 5	25 - 75	185 - 280
Line 8	20 - 100	2 - 12	50 - 100	215 - 290
Line 9	1 - 100	1 - 2	25 - 50	185 - 220

PDL 6 and PDL 7 are located at survey line 6 and survey line 7. Based on drilling data PDL 6 (Figure 8) from the surface to 6 is consist of top soil with characteristic light yellowish brown in color,soft and slightly silty clay. From 6 m to 12 m the material is firm fine sandy silty clay with color light reddish brown. Hard layer of clay found at depth 12 m up to 30 m. starting from 30 of depth till the end of drilling (300 m) represented by weathered granite. At 100 m and 280 m of depth was identified as fractured zone. In conjunction between 2D ERI result of line 6 and drilling data of PDL 6 can be correlated. The low

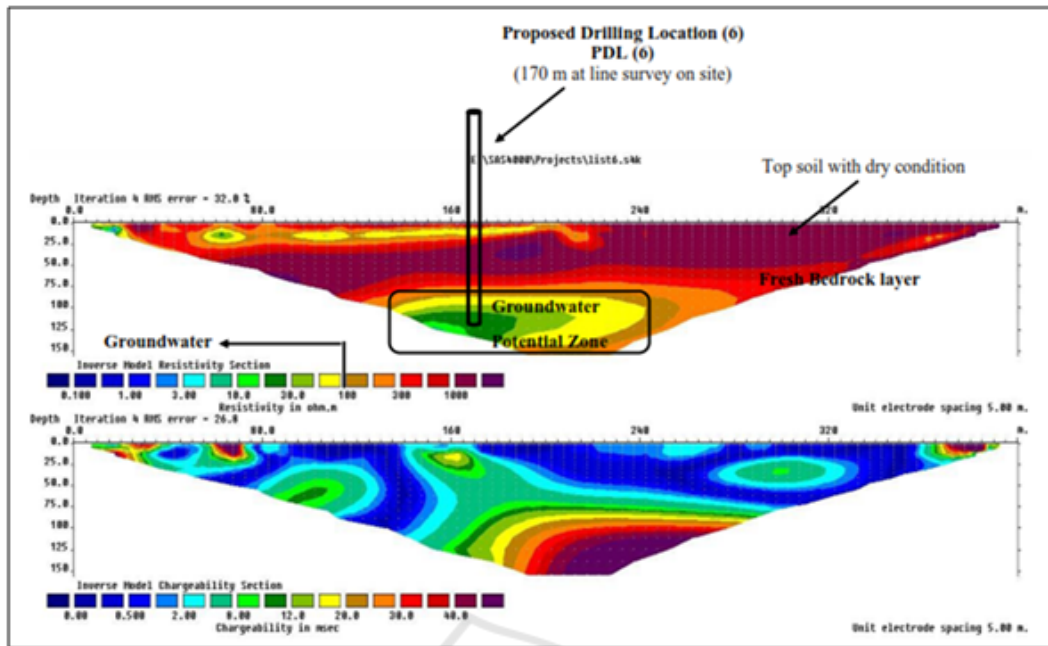


Figure 6: 2D Electrical Resistivity Imaging result of line survey 6

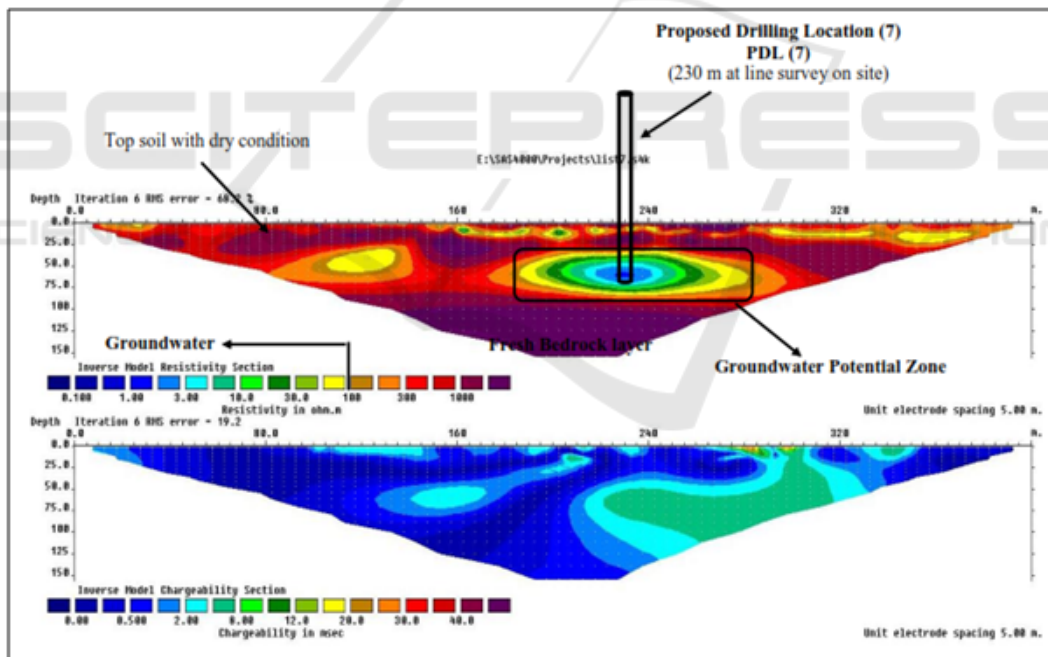


Figure 7: 2D Electrical Resistivity Imaging (ERI) result of line survey 7

resistivity value (10 – 100 Ω m) from 2D ERI result at depth 125 interpreted as groundwater potential zone and it supported by drilling data. According the drilling data, at 100 m of depth found fractured zone of granite that has very high possibility as secondary porosity to preserve groundwater resources.

PDL 6 and PDL 7 are located at survey line 6 and

survey line 7. Based on drilling data PDL 6 (Figure 8) from the surface to 6 is consist of top soil with characteristic light yellowish brown in color, soft and slightly silty clay. From 6 m to 12 m the material is firm fine sandy silty clay with color light reddish brown. Hard layer of clay found at depth 12 m up to 30 m. starting from 30 of depth till the end of drilling

Table 2: Coordinate of drilling location

Name	Coordinate	
	Latitude	Longitude
PDL 1	5° 24' 18.37" N	100° 35' 30.99" E
PDL 2	5° 24' 14.66" N	100° 35' 32.62" E
PDL 3	5° 24' 17.38" N	100° 35' 32.08" E
PDL 4	5° 24' 17.02" N	100° 35' 29.32" E
PDL 5	5° 24' 9.63" N	100° 35' 31.84" E
PDL 6	5° 24' 8.63" N	100° 35' 30.23" E
PDL 7	5° 24' 11.07" N	100° 35' 30.10" E
PDL 8	5° 24' 15.95" N	100° 35' 32.20" E
PDL 9	5° 24' 15.48" N	100° 35' 30.02" E

(300 m) represented by weathered granite. At 100 m and 280 m of depth was identified as fractured zone. In conjunction between 2D ERI result of line 6 and drilling data of PDL 6 can be correlated. The low resistivity value (10 – 100 Ωm) from 2D ERI result at depth 125 interpreted as groundwater potential zone and it supported by drilling data. According the drilling data, at 100 m of depth found fractured zone of granite that has very high possibility as secondary porosity to preserve groundwater resources.

5 CONCLUSION

2D Electrical Resistivity Imaging (ERI) Survey has been successfully used in this study to locate and delineate groundwater possibility potential at Kulim, Kedah, Malaysia in conjunction with chargeability data and drilling data. The drilling location was determined by groundwater potential zone that shown from 2D ERI result. The resistivity result show that there are 3 layers or zone within study area. First layer is top soil (clay) in dry condition represented by moderate to high resistivity value ranging from 100 – 100 Ωm at near surface. Another layer is extremely high resistivity value 300 Ωm up to 2000 Ωm that indicate granite as bedrock of study area. Groundwater potential zone shown by low resistivity value ranging from 1 – 100 Ωm. Potential zone of groundwater divided into 2 based on its depth, shallow groundwater potential with depth 25 m to 75 m from the surface and deep groundwater potential with depth more than 75 m. drilling data was proven all the interpretation of 2D ERI where the groundwater potential zone is fractured zone of granite. Fractured zone become secondary porosity that can be store groundwater.

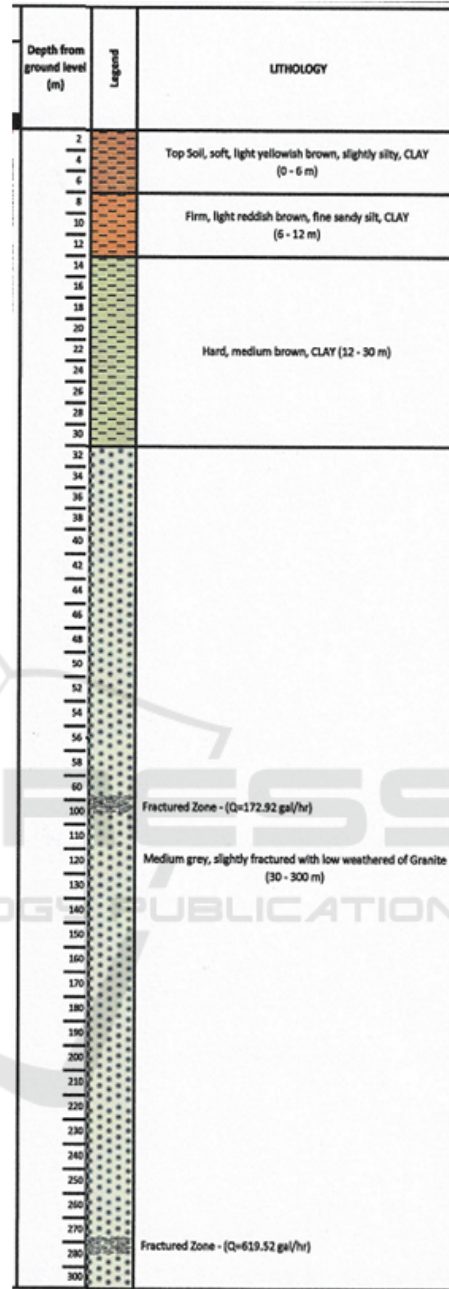


Figure 8: Drilling data of PDL 6

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