HYDROGEOCHEMICAL STUDY AND IRON REMOVAL OF GROUNDWATER IN NORTH KELANTAN

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DEPARTMENT OF GEOLOGY
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1. Name : Regional Conference On Ionic Liquid 2009 (RCiL09)
   Date : 24^{th} – 25^{th} November 2009
   Place : Faculty of Science, University of Malaya, Kuala Lumpur
   Title : Removal of Fe(III) Ion from Groundwater Using Ionic Liquid as a Solvent Medium

2. Name : 1^{st} National Conference On Natural Resources (NCNR2010)
   Date : 18^{th} – 19^{th} May 2010
   Place : Grand Riverview Hotel, Kota Bharu, Kelantan
   Title : Preliminary Study on the Application of Ionic Liquid as a Solvent Medium for Iron Removal in Groundwater

3. Name : 6^{th} Symposium of the International Geological Correlation Programme Project 516 (IGCP516) Geological Anatomy of East and South Asia
   Date : 9^{th} – 14^{th} November 2010
   Place : Faculty of Science, University of Malaya, Kuala Lumpur
   Title : Hydrogeochemical Study of North Kelantan Aquifer

4. Name : The 6^{th} Mathematicals and Physical Science Graduate Congress 2010 (MPSGC2010)
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   Place : Faculty of Science, University of Malaya, Kuala Lumpur
   Title : 1. Selected Ion Analysis of North Kelantan Aquifer
   2. Study of the Effectiveness of Ionic Liquid as a Solvent Medium for Iron Removal in Groundwater

ABSTRACT

The hydrogeochemical study and iron removal of groundwater was carried out in North Kelantan Basin. This low-lying area is covered by alluvium deposits of Quaternary age. The thickness of the alluvium may reach up to 200 m to the coast. Patches of granite hills appear in the southeast part known as Bukit Marak and Bukit Kechik that belong to Boundary Range Granite. Granite and metamorphic rock are encountered as bedrocks. Kelantan River is the main drainage of the basin with 248 km long and covers an area of approximately 11900 km^2. Hydrology study determined the baseflow index (BFI) of the basin as 0.54. This value is influenced by diverse geological, morphological and climatological aspects of the basin. Interaction between surface water and groundwater was found in the lower part of the basin while surface runoff dominanted the process in the upper part of the basin. The total precipitation received in the basin was 30.95 x 10^9 m^3/year. Water loss via potential evapotranspiration was about 40% with 50% of runoff coefficient. Based on water balance study, recharge to the aquifer was estimated about 11% from the total precipitation received. The thick sequences of alluvium deposits form an aquifer system in North Kelantan. Three layers of aquifer were identified; Layers 1, 2 and 3 with depth interval of 20 m, 20 – 50 m and more than 50 m, respectively. These layers are separated by semi permeable clay layer. Layer 1 is known as a remarkable source of public water supply in the study area as groundwater has been exploited since 1935. Hydrochemical facies reveal that the $NaHCO_3$ and NaCl facies are prevalent in the aquifer system. The evolution of groundwater is chemically governed by the process of weathering, dissolution, ion exchange and precipitation. Geochemical modeling indicates that the ferromagnesian minerals of hematite and goethite precipitate while pyrite undergones dissolution leading to an increase of iron in groundwater. The groundwater is naturally rich with iron and exceeds the WHO (2008) acceptable limit

for drinking water. Presently, conventional groundwater treatment is being used to treat the groundwater for public, agricultural and industrial purposes. Ionic liquid as a medium in liquid-liquid extraction with 1,10-phenanthroline as a chelating agent was studied as an alternative method for iron removal. Successful removal of iron was achieved with more than 95% removal from the initial concentration of groundwater samples. However, more detailed research is needed before the ionic liquid is able to replace the conventional groundwater treatment as it gives a very low recovery about 25% - 60% when reused. Furthermore, due to the ion exchange process the appearance of anion of ionic liquid also has been detected in groundwater samples.

ABSTRAK

Kajian hidrogeokimia dan pengeluaran besi dari air tanah telah dijalankan di Lembangan Utara Kelantan. Dataran lanar ini diluputi oleh enapan alluvium yang berusia Kuaterner. Ketebalan enapan alluvium dianggarkan boleh mencapai sehingga 200 m ke arah laut. Tompokan granit ditemui di bahagian timur laut kawasan kajian yang dikenali sebagai Bukit Marak and Bukit Kechik yang dikatakan berasal dari 'Boundary Range Granite'. Lembangan ini disaliri oleh Sungai Kelantan dengan 248 km panjang yang meliputi kawasan seluas 11900 km^2. Kajian hidrologi menunjukkan bahawa indeks aliran dasar (BFI) bagi lembangan ialah 0.54. Nilai ini telah dipengaruhi oleh factor geologi, morfologi dan cuaca di lembangan. Hubungan di antara air sungai – air bawah tanah hanya berlaku di bahagian bawah lembangan manakala air larian mendominasi proses di bahagian atas lembangan. Jumlah hujan yang diterima di lembangan ialah 30.95 x 10^9 m^3/setahun. Kehilangan air melalui potensi evapotranspirasi ialah 40% dengan 50% pekali air larian. Nilai imbuhan air tanah berdasarkan kajian keseimbangan air ialah 11% dari jumlah hujan yang diterima. Jujukan tebal enapan alluvium ini membentuk sistem akuifer di Utara Kelantan. Tiga lapisan akuifer telah dikenalpasti; Lapisan 1, 2 dan 3 dengan kedalaman meghampiri 20 m, 20 m ke 50 m dan lebih 50 m. Lapisan ini telah dipisahkan oleh lapisan lempung separa telap. Lapisan 1 merupakan sumber utama bekalan air di kawasan kajian yang telah dieksploitasi semenjak tahun 1935. Fasies hidrokimia yang utama dalam akuifer sistem ialah $NaHCO_3$ dan NaCl. Evolusi air tanah secara kimia dipengaruhi oleh luluhawa, perlarutan, pertukaran ion dan pengenapan. Model geokimia menunjukkan mineral ferromagnesia seperti hematite dan goethite terenap manakala pirit mengalami pelarutan yang meningkatkan kandungan lagi besi dalam air tanah. Kandungan besi yang wujud secara semulajadi sangat tinggi dalan air tanah dan melebihi piawaian air

minuman WHO (2008). Sehingga kini, kaedah perawatan air secara tradisional telah digunakan bagi merawat air tanah untuk kegunaan awam, pertanian dan industri. Cecair ionik 1-butyl-3 methylimidazoliumbis(trifluoromethanesulfonyl)imide [C_4mim][NTf_2] sebagai medium dalam pengekstrakan cecair-cecair dengan 1,10-phenanthroline sebagai agen pengkelatan. Besi telah berjaya dikeluarkan lebih 95% daripada jumlah kepekatan awal sampel air tanah. Walau bagaimanapun, kajian yang lebih terperinci perlu dilakukan sebelum cecair ionik ini boleh dikitar semula dan dapat menggantikan kaedah perawatan air secara tradisional di mana jumlah kebolehdapatan semula yang rendah antara 25% - 60% selepas dikitar semula. Tambahan pula, proses penukaran ion yang berlaku telah menyebabkan hadirnya anion cecair ionic dalam sampel air tanah.

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With Love,
~♥nhh 2011♥~

DEDICATION

Dedicated to

My Beloved Dad and Mom

(Mr. Hussin Ahmad and Mrs. Ramlah Jopree)

also

My Beloved Siblings

(Ms. Nur Haniza, Mr. Mohd Hairi, Ms. Nur Azimah and Mr. Mohd Hafidz)

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LIST OF ABBREVIATIONS AND SYMBOLS

%	-	percent
AKSB	-	Air Kelantan Sdn. Bhd.
APHA	-	American Public Health Association
CDC	-	Centers for Disease Control
DID	-	Department of Irrigation and Drainage
DOA	-	Department of Agriculture
EC	-	Electrical Conductivity
GHM	-	German Hydrological Mission
GSD	-	Geological Survey Department
ICP-OES	-	Inductively Coupled Plasma Optical Emission Spectrometer
ILs	-	Ionic liquids
INWQS	-	Interim National Water Quality Standard
mg/L	-	Milligram per liter
MGD	-	Mineral and Geosciences Department
MLD	-	Million liter per day
MMD	-	Malaysian Meteorology Department
MOH	-	Ministry of Health
RTILs	-	Room Temperature Ionic Liquids
SAR	-	Sodium Adsorption Ratio
TDS	-	Total Dissolved Solids
WHO	-	World Health Organization