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Radiological information of kelantan- A Review

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ABSTRACT

This study reviewed radiological research works conducted in the state of Kelantan, Peninsular Malaysia. A total number of eleven research articles available to the authors were reviewed and reported accordingly in this paper. From the studies it was observed that not much has been done in revealing the radiological state of the region despite been blessed with abundant granitic rock deposit. Some of the papers reviewed reported the presence of high activity concentration of naturally occurring radionuclides i.e. ^{238}U, ^{232}Th, ^{226}Ra, ^{228}Ra, ^{222}Rn, and ^{40}K in some study areas like work of (Siti Afiqah et al, 2012; Mohammed Kasim et al, 2011 etc.) while few studies were reported to be below the global and Malaysian average as can be seen in the text.

Keywords: Kelantan, NORMs, Activity, Gamma Spect.

INTRODUCTION

Kelantan is positioned in the north-east of Peninsular Malaysia, and is located on latitude 5^0 15'N and longitude 102^0 0'E (Figure 1.0) in the north-eastern corner of the peninsula, Kelantan, Kelantan has a tropical climate with temperatures from 21 to 32 °C and intermittent rain throughout the year. The wet season is the east-coast monsoon season from November to January and it is situated on granites set which is undifferentiated intrusive rock (Afiqah et al., 2011).

It is known to have high granitic content which make it to have high natural radionuclides content which in turn will make the exposure level of the area higher than that of the other region of the Peninsular.

The granitic characteristic of the region was believed to contribute significant concentrations of natural radionuclides of the family of uranium and thorium in particular.

Natural radioactivity is a source of continuous exposure to human beings. It originates from both extra terrestrial sources and radioactive elements in the earth crust (Al amer, 2008).

Natural environmental radioactivity arises mainly from primordial radionuclides such as ^{40}K and also from ^{238}U and ^{232}Th decay series, which occur at trace levels in all ground formation (Tzortlis et. al., 2004). It is important to monitor the terrestrial background radiation mainly due to these natural radionuclides in soil. Several studies performed worldwide have measured the activity concentration of natural radionuclides in soil (McAulay and Morgan, 1998; Quind'so et.al. 1994; Ahmed et. al. 1997; Karahan et. al. 2000; Al-Jundi, 2002; Matiullah et. al.

2004; Tahir et. al. 2005; Fatima et. al. 2008; Saleh et. al. 2007). The United Nation Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2000) estimated that the global average annual exposure from natural sources is 2.4 mSv/yr (WHO, 2003).

Figure 1.0: Map of Malaysia with Kelantan State Highlighted (Wikipedia, 2011).

Human beings are exposed to radiation from different sources mainly from cosmic rays and gamma emitters in soils, building materials, water, food and air (Al amer, 2008). The great interest expressed worldwide for the study of naturally occurring radiation and environmental radioactivity has led to the interest of existence surveys in many countries. Natural sources still contribute to about 80% of the collective radiation exposure of the world's population (UNSCEAR, 1993). Hence studying the levels of radionuclide distribution in the environment provides essential radiological information. Data regarding levels of natural radioactivity in soils and water and the corresponding radiation doses are lacking in the East coast of Peninsular Malaysia. The main objective of this paper is to review all radiological studies carried out in Kelantan State with an aim of bridging in the gap detected in the next study.

2.0 The Reviews:

Despite the greatest interest expressed worldwide concerning radioactivity and radiation in environment and also beside much radiological studies carried out in the Peninsular Malaysia, unfortunately not much has been done in the east coast state of the Peninsular that is Kelantan and even the ones that has been done majority were on marine sediments, the review of the work goes as follows;

- (Khanderker et al., 2013) carried out a research titled The Presence of Natural Radioactivity and ^{137}Cs in the South China Sea Bordering East Coast of Peninsula Malaysia. Their findings indicated a presence of relatively low activity concentrations in marine life when compared against values for mollusk and several other sea bottom living organisms including pari (skate). Furthermore, their findings show the presence ^{226}Ra and ^{228}Ra were detected only in sea water obtained 50 km offshore which potentially was as a result of water from offshore oil and gas production facilities, a positive correlation was also found to exist between the activities of naturally occurring radionuclides with distance offshore and that of sediments samples observed at a depth below the sea level. However, ^{137}Cs which is an anthropogenic radionuclide was only detected in deep sea sediment only at low concentration a such in no case were the activity concentrations levels might be of concern but since seafood is a major dietary item in Peninsula Malaysia their research can served as a reference point and should be considered in assessing any future impact of radiological contamination.

- In 2012 (Siti Afiqah et al.,) carried out an evaluation assessment of Natural Radioactivity in soil of Kuala Krai District, Kelantan Darul-Nai'm, the samples collected from the fist, second and third layer were evaluated using Gamma Spectrometer for ^{226}Ra, ^{228}Ra and ^{40}K. the activity concentrations ranges from 47.1-251.1(^{226}Ra), 54.2-284.4(^{228}Ra), and 491.1-2495.6(^{40}K) for first layer soil then 48.6-426.7(^{226}Ra), 50.4-457.1(^{228}Ra), and 473.4-

2615.9(^{40}K) for second layer soil and lastly 43.0-430.3(^{226}Ra), 44.5-441.1(^{228}Ra), and 488.2-2632.2(^{40}K) for third layer soil all readings are in Bq/Kg, the readings were used for radiological assessment of the area, and it was found that the exposure risk to radiation for those living and drinking water from the area is very significant because the activity of the area (Kuala Krai) was higher than the Malaysia average value as well as two times greater than the non-granitic region from other part of the world as reported by UNSCEAR.

- (Mohammed Kassim et al., in year 2011) determined activity concentration of Radon in hot spring and surface water using gamma spectrometry techniques with High Purity Germanium detector (HPGe), the groundwater samples were collected from Kelantan, Perak, Selangor and Sembilan while the surface water samples were collected from Kelantan, Perak and Pahang. Surface background gamma dose rates measurements were taken at each sampling point using a LUDLUM radiation rate meter. Their studies shows that the radon concentration levels in hot spring and surface water samples ranges between (0.29-1.41) Bq/l which is within international acceptable limits of 11.1 Bq/l set by USEPA, 1999. However, the surface radiation doses measured at 1m and above the surface were found to be range between 0.088-0.137 µSv/hr and 0.096-0.232 µSv/hr respectively and for all locations. But the doses obtained are more than the global range at selected sites which is a cause for concern.

- Radiation hazard from naturally occurring radioactivity in the sediments of the east coast peninsular Malaysia economic exclusive zone (EEZ) were determined by (Yii Mei-Wo et al., in 2011). Sixteen marine core sediments were collected by Yii and co. and quantified using high purity germanium detector coupled to a spectrometer, radiological information parameters were calculated from the quantified NORM's concentrations. The parameters calculated are Radium equivalent (Ra_{eq}), Representative level index ($I_{\gamma i}$), and external hazard index (H_{ex}) with respective values ranges 68.6-210.5 Bq/kg, 0.50-1.54 Bq/kg, and 0.19-0.57 Bq/kg, and also mean value of 143 ± 27.7 Bq/kg, 1.04 ± 0.20 Bq/kg, and 0.39 ± 0.07 Bq/kg for Ra_{eq}, $I_{\gamma i}$, and H_{ex} respectively. Their result shows that the calculated radiological parameters were well below the recommended limit value of 370 Bq/kg and unity for Ra_{eq} and H_{ex} respectively, while the representative index was found to be slightly less than the background radiation level from soil in Peninsular Malaysia $I_{\gamma i}$ ~ 1.5. Therefore, it can be said that the additional exposure received by people handling the samples were small, when compared to the one received from the background radiation, which means there is need for a frequent monitoring for data validation when compared the work of others in some places in the zone.

- However, due to the observed granitic characteristics and some uranium mining activities taking place in Kuala Krai a district in the state of Kelantan, Abdul Rahman Siti Afiqah and his colleagues measured the activity concentrations of ^{226}Ra, ^{228}Ra and ^{40}K in fourteen soil samples collected along the river basin in the granitic region using Gamma spectrometer and the results obtained were used in estimating the radiation hazards indices and the annual exposure rate posed to the public. Their findings shows a concentrations range of 49.2-312.9 Bq/kg for ^{228}Ra, 491.1-1184 Bq/kg and a high activity concentration of ^{226}Ra as 40.2-264.0 Bq/kg. The high activity concentration observed in this area was attributed to the granitic region of the area that has been believed to have a potential uranium deposit. The external radiation hazard index of the area was found to be 0.43-2.02, and this results can served as a baseline data for future study in the area and neighbouring territories.

- An assessment of radiochemical parameters of Kelantan river basin was carried out by (Siti Afiqah et al, 2011), in which activity concentrations of gross alpha, gross beta, ^{222}Rn and ^{226}Ra were determined in 20 water samples collected across the river basin using liquid scintillation counter. Their finding shows a weak correlation between temperature, specific conductivity, pH and turbidity with ^{222}Rn and ^{226}Ra activity concentrations which make it not possible to determine the water chemistry between them. The results obtained ranges 0.39-6.42, 0.66-16.18, 0.40-4.65 and 0.05-0.56 Bq/L gross alpha, gross beta, ^{222}Rn and ^{226}Ra respectively with respective minimum detectable activity (MDA) as 0.03, 0.08 and 0.00035 Bq/L. However, activity concentrations of gross alpha, gross beta, ^{222}Rn and ^{226}Ra was higher in some certain areas and this was attributed to the geological features and chemical composition of the river basin which might be as a result of geological erosion from the ground water and dissolution of uranium-bearing rocks due to changing of temperature in the earth crust. Going by their findings it can be said that there is need for further study for data validation and also to determine the annual dose received by the consumers especially for tourism, water supply and agricultural purposes in the area and the state at large.

- (Zaini Hamzah et al., 2011.), carried out an assessment of outdoor radiation hazard of natural radionuclides at tourism beach areas in 18 beaches at eastern, south western and southern coast of Peninsular Malaysia in which also an in-situ surface radiation dose measurements were recorded simultaneously with sample collection using a

portable radiation survey meter, while the activity concentration of the collected sand samples were carried out using gamma ray spectrometer. The surface radiation dose rate were found to range between 0.04 to 0.12 µSv/hr, while they found the mean activity concentrations of ^{238}U, ^{232}Th and ^{40}K to vary between 7.3-51.0, 5.9-58.4 and 32.7-1293 Bq/kg respectively with their corresponding annual effective dose ranged between 0.051 and 0.552 mSv/y which was below the average worldwide exposure of 2.4 mSv/y with a calculated radiation hazard index ranged between 0.05 and 0.51. They reported in their results that the activity concentrations of the three radionuclides to be relatively lower than the world's average and the hazard posed to the general public can be considered to be low. But surface dose measurements showed much higher values than the calculated annual effective dose thus indicating cosmic radiation doses and doses from other terrestrial radiation sources exceeded the combined doses of the three radionuclides.

- In 2011, Radon activity concentration in water was determined using Gamma spectrometry and Liquid scintillation counter techniques by (Ahmad Saat et al.), and determined the radon activities to be ranged between 0.156 to 1.876 Bq/l, which is within the acceptable limit of 11.1 Bq/l set by USEPA, 1991, but the concentration was observed to differ at different sites and this might be due to different origins, depth and pathways of the out flowing water. In addition, the surface radiation dose measured at the surface and 1m above the surface ranged between 0.103-0.228 µSv/hr and 0.104-0.223 µSv/hr respectively for all locations. They also found a good correlation between the two analytical techniques thus recommended that any of the two methods for the determination of radon in water.

- Being known as a granitic region, state of Kelantan lack data/information about ^{226}Ra concentration in water sources, thus, (Siti Afiqah et al., 2010) reported a result of their research titled measurement of ^{226}Ra in water using liquid scintillation counting techniques, in which they found the activity concentrations of ^{226}Ra ranging between 0.1095-0.5483 Bq/L with the highest value found at Manik Urai Bridge, the result have exceeded the INTERIM National Water Quality Standard for Malaysia (INWQS) limit of 0.1 Bq/L. Their results indicate that ^{226}Ra has been dissolved in the water rather than being attached to the suspended solid.

- (Nurulhuda Kassim et al., in 2010) presented a result of their research titled Determination of surface radiation dose and concentration of uranium and thorium in soil at UiTM Perhilitan research station Kuala Keniam, Taman Negara, Pahang using energy dispersive x-ray fluorescence (EDXRF). Their research involved in-situ surface radiation dose measurement using a portable radiation survey meter at the surface and 1m above the surface and soil analysis using EDXRF techniques. The result obtained shows a mean value of 0.164 µSv/hr as a mean value for surface dose rate on the surface, and 0.161 µSv/hr as a mean surface dose rate on 1m above the surface. The surface dose rate ranges 0.125-0.277 µSv/hr which indicates normal dose range and also falls below global dose range of 0.5-1.3 µSv/hr set by UNSCEAR. Uranium concentration in their studies was found to be ranged between 0.46 µg/g to 0.75 µg/g which falls below the world average value of 1.8 µg/g, and Thorium concentration was found to be ranged between 2.02 µg/g to 3.19 µg/g which was also below the world average value of 6.2 µg/g which means the reserved area was not radiologically elevated a such safe for habitation.

- In 2006 (Omar et al.), measured and reported the radiation exposure while travelling in Malaysia, in the report absorbed dose rates in vehicles while travelling via different transportation modes in Malaysia were measured. Their findings show the radiation level measured on roads in the Peninsular Malaysia to vary broadly with a ranged of 36 to 1560 nGy/h. The highest reading was recorded near monazite and zircon dumps sites while travelling and is about 13 times more than the environmental mean radiation level of Malaysia, which was an evident that mineral dumps along the roads can influence elevated radiation level on the road. The highest reading measured while travelling by an ordinary train was when the train was passing through a tunnel built up through a granite rock hill with a dose rate range of 60 to o 350 nG/h which was a clear evident that the elevated dose was as a result of the granitic rock which has in abundance uranium deposition. While on the hand lowest radiation level was measured while travelling via ferries during sea travelling and this was due to merely cosmic radiation at sea level. In general based on this research even though the radiation levels in some places on land were significantly high, the highest exposure may come from air travelling and this is due to exposure time.

CONCLUSION

A review of radiological studies carried out in Kelantan State, Malaysia by various researchers has been conducted and reported in this paper. On course of the review it was observed that there was little information about

radiological information of the state despite been one of the economic giant in the Peninsular Malaysia as well as being rich in granitic rock deposit which houses Uranium a major player/ contributor to environmental natural radioactivity. However, from the studies it has been found that some of the areas studied by the researches like Manik Urai etc. has a high elevated radioactivity while some were moderate and low, therefore, the review will serve as a guide for future studies since it has become necessary in order to have a full information about the total radiological state of the entire region, and that is what the authors of this paper embark on now.

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