DISTRIBUTION COEFFICIENT Kd OF CESIUM IN SOILS FROM AREAS IN PERAK

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ABSTRACT:

This is the paper reports on the study of distribution coefficient or Kd value in soil collected from the Western of Perak, which is Manjung, Setiawan, and Lahat with two different depths using lab batch method. Particle sizes were analyzed using the conventional technique known as pipette method. pH of the sample were 2-3. Determinations for cesium were performed using Inductively Coupled Plasma-Mass (ICP-MS). From the results, distribution factor for cesium, Kd value, was found to be influenced by the particle size of soil.

Key words: Kd value, cesium, soil, ICP-MS, particle size

1.0 INTRODUCTION

Release of radioactive materials from nuclear activities to the environment is a great concern to the general public. Once in the environment, these contaminants could enter the food chains, contaminate water supply systems and may end up in human body through ingestion. The impact of radioactive pollution in soil depends not only on the concentrations soil to water, from groundwater to plants and etc. Cesium-137 is the most important long-tem contributor to environmental contamination because of its high release rate, simulated as 1.3×10^{-6} Bq (Chino et al. 2011), and longer half life (30.1 y). With the latest nuclear accident in Fukushima, as example, results of environmental gamma-ray dose rate monitoring ang the measurement of ^{137}Cs concentration in soil revealed that high level of ^{137}Cs were deposited on land (Atsushi N, et al. 2012). The wide spread dispersion of this radionuclide prompted serious concerns about the risk to public health because most of the ^{137}Cs that deposited on land remains in the surface soil for decades.

Major factors that control the mobility and availability of radionuclides in soils are their physicochemical properties of radionuclide such as solubility and ionic species, soil type such as particle size or mineralogy and water chemistry of particular environment such as pH, competing ions, ionic strength and etc (Ames, L.L., and D. Rai, (1978). These mobility and availability of radionuclides in soil can be measured by using distribution coefficient, Kd value. Distribution coefficient defines as the ratio contaminant or radionuclide concentration bound on solid phase (soil) to the contaminant concentration remaining in the liquid phase at equilibrium. Kd value of elements in soils and rocks for different environments range from 0.03 in sandy soil to 20,000 in clayey soil (Rhodes, 1996).

2.0 METHODOLOGY

Samples were collected from Western of Perak, at about 30 different locations with two different depths; which are the top soil (0-15 cm), and the sub soil (15-30 cm). Figure 1 showed the location mapping of soil sampling at Western of Perak. Samples were collected using an auger and transfer into the polyethylene bag and brought back to the lab. The samples were air dried and, breaking the agglomerates with the hand grind mortar, sieved through 2 mm sieve for the further analysis.

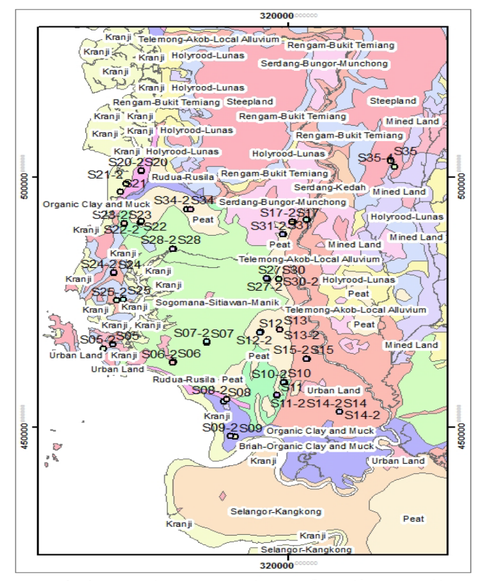
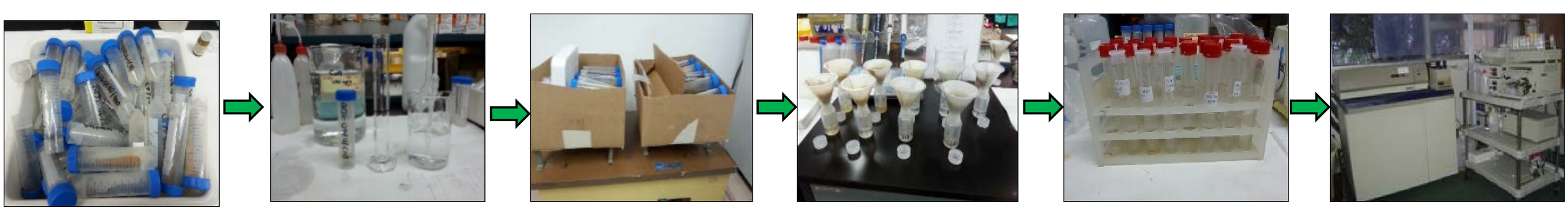


Figure 1: Location mapping of soil sampling at Western of Perak

2.1 Soil properties - particle size analysis

Particle sizes of each sample were analyzed using the pipette method. 5 grams sample were shake with 40 mL of 0.5 % SHMP (Sodium hexametaphosphate) solution for 16 hours. After that, stop shaking and 2.5 mL of mixed components were collected at 2.5 cm after 10 sec and 1 hr 40 min to collect silt + clay and clay components respectively, and transferred into a small petri dish. The particles were dried at 60 °C and measured their weight to obtain the percentage of components (Ministerial Decree, 1999).

2.2 Kd value determination



1g of soil was weigh

1g of soil mixed with 30 ml of cesium solution

The soil samples were shake for 3 days

Filter the soil sample using filter paper

Dilution process with 3% HNO3 (v/v)

Analysis sample using ICP-MS

3.0 RESULT & DISCUSSION

Code sample	% sand	% silt	% clay	Kd value for Cs
D13/0745-A	84.0	9.0	7.0	0.903
D13/0745-B	77.1	10.9	11.9	2.724
D13/0746-A	27.0	47.6	25.4	4.470
D13/0746-B	22.5	45.0	32.4	2.179
D13/0747-A	41.3	34.6	24.1	4.580
D13/0747-B	34.8	33.3	31.9	4.247
D13/0748-A	31.4	48.2	20.4	11.054
D13/0748-B	64.2	18.1	17.7	8.568
D13/0749-A	24.7	48.2	27.1	31.140
D13/0749-B	-0.2	84.7	15.5	31.743
D13/0750-A	49.6	23.2	27.2	5.436
D13/0750-B	48.7	23.2	28.1	6.081
D13/0751-A	33.1	29.2	37.6	12.953
D13/0751-B	29.3	18.5	52.2	12.616
D13/0752-A	61.7	30.5	7.8	12.339
D13/0752-B	55.3	34.1	10.6	13.499
D13/0753-A	46.0	21.8	32.2	9.063
D13/0753-B	18.4	20.6	61.0	12.167
D13/0754-A	6.8	48.0	45.2	24.879
D13/0754-B	8.4	48.4	43.2	20.828
D13/0755-A	28.2	52.3	19.5	9.501
D13/0755-B	3.0	61.7	35.3	10.807
D13/0756-A	7.7	60.6	31.7	13.415
D13/0756-B	5.0	61.3	33.7	11.639
D13/0757-A	11.8	45.3	42.9	11.143
D13/0757-B	16.9	31.6	51.6	9.460
D13/0758-A	71.9	17.6	10.5	2.561
D13/0758-B	60.5	25.0	14.6	5.842
D13/0759-A	94.1	2.8	3.1	0.056
D13/0759-B	95.3	1.5	3.3	1.938

Table 1: Result for soil particle size and Kd value for cesium area sampling of Western of Perak

As the graph below, which plotted in Figure 2 shown that the Kd value for cesium were influence by the particle size. Table 2, shown the ranges of Kd values in different type of soils for the sampling result analysis. The soil's group fraction is according to; sandy - which is soil contain ≥ 35 % sand, clay - which is soil contain ≥ 35% of clay, and loam for rest of cases.

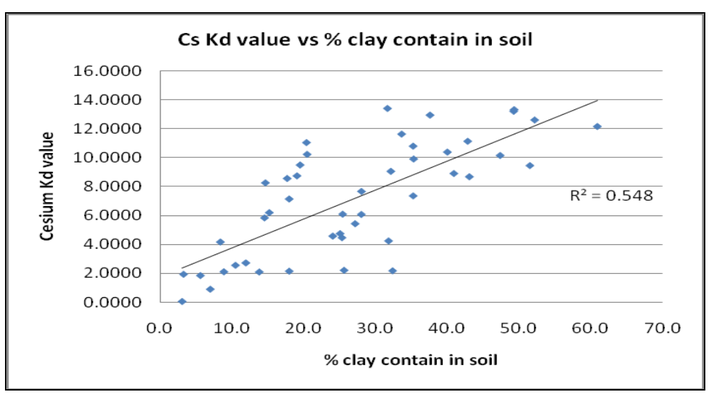


Figure 2: Cesium Kd value vs % clay contain in selected soil for areaWestern of Perak

Soil groups	Kd value for cesium
Sandy	0.903 - 13.499
Loam	2.179 - 13.415
Clay	12.616 - 24.879

Table 2: Range of cesium Kd value for in different type of soils

For cesium, distribution coefficient, the Kd values varied significantly among the sample type. Kd value was found to be related with the type of soil. Basically more clay contain in the soil will give the higher value for cesium distribution coefficient, Kd. Therefore in this study results were generally give a lower Kd values for sandy type soil compare to clay type soil.

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