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HEAVY METALS CONTENT AND ITS CORRELATION WITH CLAY COMPONENT CONTENT IN COASTAL ALLUVIAL SEDIMENT IN NGHIA HUNG DISTRICT, NAM DINH PROVINCE, IN THE NORTH OF VIETNAM

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Abstract

This report presents results of research on heavy metals (Pb, Cu, Zn, As, Cd, Hg) and correlation between their contents and clay component contents (< 0.005 mm and 0.001 mm) in coastal alluvial sediment in the area lies between Ninh Co and Day river mouths in Nghia Hung district, Nam Dinh province, in the North of Vietnam.

According to analysis results, content values of Pb are ranged from 1 ppm to 62 ppm and there are 12/27 samples which have values higher than TELs (30.2 ppm); content values of Hg are ranged from 0.1 ppm to 2.5 ppm and there are 5 samples which have values higher than TELs (from 12 to 19 times higher than TELs); content values of As are ranged from 1 ppm to 10 ppm and there are 2 samples which have values higher than TELs; content values of Cu are ranged from 3.4 ppm to 130 ppm and there are 15/27 samples which have values higher than TELs (18.7 ppm); content values of heavy metals (Zn, Cd) are under TELs. Thus, there is accumulation of some heavy metals which are harmful to human and creatures such as Pb, Cu, Hg, As in alluvial areas in Nghia Hung province.

According to calculating of correlation between heavy metals and clay component contents, there is a linear correlation between contents of some heavy metals (Cd, Hg) and clay components. Therefore, further research on mechanism of heavy metals accumulation in sediment and sources of heavy metals supply in the area should be carried on.

Keywords: alluvial, clay component, content, correlation, heavy metal, sediment

Introduction

Location of research area is on South coast of the Red River Delta, 150 kilometers South East far from Hanoi. Research area is a coastal alluvial area which lies between Ninh Co and Day River mouths in Nghia Hung District, Nam Dinh Province. There is a different in environmental motivation force condition. Major processes in Ninh Co River mouth are erosion and invasion while in Day River mouth is alluvial and sediment accumulation processes. Results of this report are retrieved from project "Investigation, analysis and assessment of soil and water environment in coastal alluvial areas in Nghia Hung district, Nam Dinh province" which carried out by Hanoi University of Science and Institute of Aquacultural Economic and Planning in 2 years (2002 - 2003).

Samples were taken parallel and perpendicularly to the national dike by hand drills deep to 1.2 m. Analysis categories are physio-mechanics (grain composition), chemical composition (N, P, humus, K, Na, etc.) and heavy metals. There are 27 samples of heavy metals and grain composition chosen to analyze and assess their correlation.

Methods

Samples were taken by hand drills at an average depth of 0.5 - 0.7 m with the weight of 1.5 - 2 kg. After naturally drying samples were divided into 4 parts which were used for grain analysis, chemical composition analysis, heavy metals analysis and preserved sample.

Grain compositions were analyzed by traditional methods which are sifting and pipet in laboratory of Marine sediment and Geology, Faculty of Geology, Hanoi University of Science. Grain compositions of samples include sand (> 0.25 mm and 0.25 - 0.1 mm), powder (0.1 - 0.05 mm; 0.05 - 0.01 mm), clay (0.01 - 0.005 mm; 0.005 - 0.001 mm and < 0.001 mm). Furthermore, we also analyzed accumulative curves, grain distribution curves, selective coefficient (So), symmetrical coefficient (Sk), medium grain size (Md). Those curves and coefficients help to define origin of sedimentary samples.

Samples of heavy metals analysis with the weight of 1 g were dried in drier cabinet at temperature of 105⁰C in 6 hours. SiO₂ in samples was eliminated by HF acid chemical pure PA; organics were eliminated by HClO₄ acid. Then remaining samples were dissolved in HCl acid chemical pure PA and fixed to measure by atomic absorption spectrum AAS - Perkin Elmer in Research Center for Environmental Technology and Sustainable Development - Vietnam National University, Hanoi. Standard substance was mixed from solutions of corresponding metal salt with initial concentration is 1,000 ppm. Spectral wavelengths used to define corresponding heavy metals are Pb 2,833 Å⁰, Zn 3,139 Å⁰, Cd 2,288 Å⁰, Cu 3,247 Å⁰, Hg 2,537 Å⁰, As 1,937 Å⁰. Sensitivity of measurement method is > 10⁻² ppm.

Coefficients of correlation between heavy metals and clay component contents of samples were calculated separately for each heavy metal with content values of component are < 0.005 mm and < 0.001 mm by common statistical method:

- $r_{\text{hột - kl}}$: r is correlation coefficient in case content of component is < 0.005 mm and corresponding metal.
- $r_{\text{sét - kl}}$: r is correlation coefficient in case content of component is < 0.001 mm and corresponding metal.

Results and Discussions

Analysis results of 27 samples are shown in Table 1.

Table 1. Grain composition and heavy metals content in analysis samples in coastal alluvial in Nghia Hung district, Nam Dinh province

N ^o	Percentage of grain composition (%)			Contents of heavy metals in samples (ppm)					
	> 0,005 mm	0,005 - 0,001 mm	< 0,001 mm	Zn	Cd	Pb	Cu	As	Hg
1	87,69	7,00	5,31	1,1	-	1,8	4,2	3,0	0,1
2	84,60	9,03	6,37	1,2	-	1,0	4,3	3,0	0,1
3	62,15	22,14	15,71	50	<0,1	27	60	1	<0,5
4	44,52	29,81	25,67	80	<0,1	65	120	10	<0,5
5	76,82	11,73	11,45	30	<0,1	36	60	1	0,1
6	74,28	14,29	11,43	90	<0,1	57	110	5	1,5
7	64,03	18,72	17,25	70	0,2	29	60	3	<0,5
8	71,09	15,60	13,31	80	<0,1	52	10	5	2,5
9	84,57	9,10	6,33	70	<0,1	25	90	3	<0,5
10	90,47	4,79	4,56	90	<0,1	61	110	6	0,1
11	62,04	22,11	15,85	60	<0,1	51	100	6	2,5
12	96,25	1,11	2,64	1,2	-	1,0	3,3	3,0	0,1
13	82,06	14,07	3,87	1,2	-	1,4	6,7	3,0	0,1
14	90,01	8,99	0,00	3,4	0,05	9,0	3,4	5	0,1
15	86,09	9,89	4,02	14,0	0,10	17,0	5,4	5	0,1
16	87,14	8,22	4,64	4,2	0,06	12,0	4,1	6	0,1
17	79,21	11,41	9,38	7,5	0,10	24,0	8,1	10	0,3
18	73,98	16,08	9,94	9,4	0,09	15,0	3,7	8	0,1
19	93,01	3,80	3,19	1,2	0,01	1,0	3,7	2	0,1

20	64,31	21,21	14,48	70	<0,1	47	90	4	<0,5
21	92,88	1,98	5,14	100	<0,1	62	130	5	<0,5
22	91,72	4,76	3,52	50	0,1	28	70	4	1,5
23	89,68	4,13	6,19	40	<0,1	16	60	1	<0,5
24	51,14	22,77	26,09	40	<0,1	23	60	3	<0,5
25	71,09	15,60	13,31	80	<0,1	52	10	5	2,5
26	53,54	25,71	20,75	70	0,2	52	100	3	<0,5
27	64,97	15,34	19,69	40	<0,1	62	90	5	<0,5
Threshold Effect Levels (TELs) Canada				124	0,676	30,2	18,7	7,24	0,13
Probable Effect Levels (TELs) Canada					4,21			41,6	0,70

According to Table 1, there are 12/27 samples have content value of Pb higher than TELs; 15/27 samples have content value of Cu higher than TELs; 3/27 samples have content value of As higher than TELs and 6/27 samples have content value of Hg higher than TELs. Maximum content values of heavy metals in some samples are higher than TELs for Pb is 2 times, Cu is approximately 7 times, As is approximately 1.5 times, Hg is 19 times higher than TELs. Samples which have high content of heavy metals also have high content of clay component. Content of heavy metals in alluvial sediment in Nghia Hung is rather high in comparison with in other coastal areas in Vietnam (presented by the same authors) [2, 5, 6, 7, 10].

Table 2. Contents of heavy metals in coastal and river mouth sediment in Vietnam (presented data)

N ^o	Authors, years	Contents of heavy metals in sediment mg/kg (ppm)					
		Pb	Cu	Zn	As	Hg	Cd
1.	Dao Manh Tien, Mai Trong Nhuan et al., 1998	18-0,5 Tb. = 4	110-0,1 Tb = 9	61-0,5 Tb=2	6,1-0,2 Tb.=1,5	2-0,05 Tb.=0,3	
2.	Pham Khac Lam, Pham Van Ninh, 1998 + Dry season + Rainy season	5-31 Tb.=17,83 14,4-250,4 Tb=35,9	34-118,5 Tb=74,5 99-172 Tb=138	10,5-28 Tb.=17 0,0-79,3 Tb=52			0,0-3,58 Tb=1,87
3.	Le Thi Vinh, 1998		1,4-9,08	1,5-5,1			
4.	Hoang Anh Le, 2002	0,95-15,9 Tb= 9,69	1,8-28,6 Tb.=13	8,7-22,99 Tb.=16,1	0,05=0,54 Tb=0,27		0,015-0,11 Tb=0,045
5.	Luu Duc Hai et al., 2002	1,0 - 24	1,5-8,7	1,2-14	2-10	0,1-0,3	0,01-0,1
	Threshold Effect Levels (TELs)	30,2	18,7	124	7,24	0,13	0,676
	Probable Effect Levels (TELs)				41,6	0,70	4,21

Results of calculating of correlation between heavy metals and clay component (<0.005 mm and < 0.001 mm) contents in sediment are shown in Table 3.

Table 3. Coefficients of pair correlation between heavy metals and clay component (< 0.005 mm and 0.001 mm) content in sedimentary samples taken in coastal alluvial areas in Nghia Hung district, Nam Dinh province

Component	Metals					
	Cd	Hg	Pb	Cu	Zn	As
< 0,005 mm	$r_{\text{bét - Cd}} = 0,879$	$r_{\text{bét - Hg}} = 0,698$	$r_{\text{bét - Pb}} = 0,503$	$r_{\text{bét - Cu}} = 0,49$	$r_{\text{bét - Zn}} = 0,408$	$r_{\text{bét - As}} = 0,2$
< 0,001 mm	$r_{\text{sĐt - Cd}} = 0,902$	$r_{\text{sĐt - Hg}} = 0,713$	$r_{\text{sĐt - Pb}} = 0,563$	$r_{\text{sĐt - Cu}} = 0,49$	$r_{\text{sĐt - Zn}} = 0,452$	$r_{\text{sĐt - As}} = 0,16$

Data in table 3 show that contents of Cd, Hg have closed correlation with contents of clay components in samples. Contents of Pb, Cu and Zn have weak correlation with contents of clay components in sedimentary samples. There is only no correlation between content of As and clay component of samples.

Correlation between heavy metals and clay component contents in samples relates to capacity of heavy metal absorption on surface of clay colloids. River currents carry heavy metals absorbed clay colloids to river mouths. There they deposit with other sedimentary components, thus lead to accumulate heavy metal in sediment in research area.

Mechanism of heavy metals accumulation in coastal sediment and capacity of heavy metals accumulation in aquacultural products in the area should be continuously studied in order to limit negative impacts of heavy metals on environment and human health.

Conclusions

1. Results show that content values of Pb are ranged from 1 ppm to 62 ppm and there are 12/27 samples which have values higher than TELs (30.2 ppm); content values of Hg are ranged from 0.1 ppm to 2.5 ppm and there are 5 samples which have values higher than TELs (from 12 to 19 times higher than TELs); content values of As are ranged from 1 ppm to 10 ppm and there are 2 samples which have values higher than TELs; content values of Cu are ranged from 3.4 ppm to 130 ppm and there are 15/27 samples which have values higher than TELs (18.7 ppm); content values of heavy metals (Zn, Cd) are under TELs. Thus, there is accumulation of some heavy metals which are harmful to human and creatures such as Pb, Cu, Hg, As in alluvial areas in Nghia Hung province.

2. Coefficients of pair correlation between content of clay component (< 0.001 mm) with Cd, Hg, Pb, Cu, As and Zn are 0.902, 0.713, 0.563, 0.49, 0.452, 0.16. Coefficients of pair correlation between content of clay component (< 0.005 mm) with Cd, Hg, Pb, Cu, As and Zn are 0.879, 0.698, 0.49, 0.408, 0.2.

3. Mechanism of heavy metals accumulation in coastal sediment and capacity of heavy metals accumulation in aquacultural products in the area should be continuously studied in order to limit negative impacts of heavy metals on environment and human health.

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