



# NUCLEAR TECHNIQUES TO ADDRESS HAB CONCERNS

Vu Nhu Ngoc, Phan Son, Nguyen Ngoc Lam and Chu Van Thuoc

*Nuclear Research Institute*

**ABSTRACT:** In December, 1998, The Project Formulation meeting on application of Nuclear Techniques to address red tide (Harmful Algal Bloom concerns) was held in Manila Philippines. This is an IAEA/RCA project with the participation of Australia, China, Indonesia, Malaysia, Pakistan, The Philippines, Thailand and Vietnam. The main objectives of this project (RAS/8/076) included:

- Conduct of segmentation studies to gain information on the natural histories of sediments and to correlated these with Red Tide occurrences.
- Development of descriptive and predictive of the behaviour of Algal Bloom as affected by the interplay of the causative organism with the environment parameters in the water column and sediments.
- Development and field testing of a rapid assay technique based on tritium – labeled saxitoxin for toxin determination. The first phase has been completed in 2002 and the second phase will be completed in 2004. In the two years of 2001 – 2002 Red Tide has occurred in very larger area in Vietnam, for example, in the coast of Binh Thuan Province with the density of  $39.10^9$  cells/litre. The Ministry of science – technology environment of Vietnam has support 5.000 USD each years for sediment and algal sampling in Cam Ranh Bay (Nha Trang,  $11^{\circ}45N$  and  $10^{\circ}15E$ ) and Ha Long Bay in the North - East of Vietnam ( $21^{\circ}15$  and  $107^{\circ}3E$  ) and in 2003 in Tuy Phong Bay (Binh Thuan province) ( $10^{\circ}15N$ ,  $108^{\circ}45E$ ). Three sediment core has been taken from Cam Ranh Bay, Ha Long Bay and Tuy Phong Bay. The volume of sediment core is  $\phi = 8cm$  and  $h = 60cm$ . The algal samples have been collected by Bongo nets in Cam Ranh, Ha Long Bay and Tuy Phong Bay.

In the two years of 2001 – 2002 Red Tide has occurred in very larger area in Vietnam, for example, in the coast of Binh Thuan Province with the density of  $39.10^9$  cells/litre. The Ministry of Science, Technology and Environment of Vietnam has support 5.000 USD for sediment and algal sampling in Cam Ranh Bay (Nha Trang,  $11^{\circ}45N$  and  $10^{\circ}15E$ ), Ha Long Bay in the North - East of Vietnam ( $21^{\circ}15$  and  $107^{\circ}3E$  ) and Tuy Phong Bay ( $11^{\circ}15N$  and  $108^{\circ}45E$ ) in Binh Thuan province in Central Vietnam. Three sediment core has been taken from Cam Ranh Bay. The volume of sediment core is  $\phi = 6cm$  and  $h = 50cm$ . The algal samples have been collected by Bongo nets in Tuy Phong Bay.

## I. Neutron activation analysis for determination of Co, Fe, Mn, Zn, Mg and K in sediment samples

**Table 1:** The mean value of some metal in sediment samples from Tuy Phong Bay

No	Samples	K (ppm)	Mg (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	Co (ppm)
1	PT 1	$10900 \pm 1200$	$11800 \pm 800$	$111 \pm 8$	$16800 \pm 1200$	$43.0 \pm 2.0$	$20.2 \pm 1.1$
2	PT 2	$13500 \pm 1100$	$11400 \pm 800$	$113 \pm 8$	$18000 \pm 1300$	$49.7 \pm 2.2$	$22.7 \pm 1.2$
3	PT 3	$12000 \pm 1100$	$9400 \pm 900$	$123 \pm 7$	$19000 \pm 1300$	$46.5 \pm 2.1$	$23.2 \pm 1.2$

No	Samples	K (ppm)	Mg (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	Co (ppm)
4	PT 4	12000 ± 1100	7900 ± 900	71.6 ± 5	13500 ± 1100	29.3 ± 1.2	15.6 ± 1.0
5	PT 5	6600 ± 900	37400 ± 1500	77.8 ± 5	16400 ± 1200	38.4 ± 2.0	18.8 ± 1.1
6	PT 6	10400 ± 1200	8400 ± 900	100 ± 8	15100 ± 1200	31.1 ± 2.1	17.9 ± 1.1
7	PT 7	9800 ± 1200	9700 ± 900	76.3 ± 6	14600 ± 1100	30.8 ± 2.0	16.6 ± 1.0
8	PT 8	9800 ± 1200	7500 ± 1000	93.2 ± 8	15000 ± 1200	34.1 ± 2.1	17.3 ± 1.1
9	PT 9	11500 ± 1200	9000 ± 900	85.2 ± 6	14500 ± 1100	31.0 ± 2.0	18.1 ± 1.1
10	PT 10	12400 ± 1100	8800 ± 900	90.1 ± 8	12500 ± 1200	28.8 ± 1.4	14.8 ± 1.0
<b>Average</b>		<b>10890</b>	<b>12130</b>	<b>94.12</b>	<b>15540</b>	<b>36.27</b>	<b>18.52</b>
11	CN 1	8900 ± 900	6600 ± 900	62.3 ± 4	11600 ± 1200	23.3 ± 1.0	12.2 ± 1.0
12	CN 2	7600 ± 900	7200 ± 900	76.6 ± 5	13200 ± 1200	24.6 ± 1.0	14.3 ± 1.1
13	CN 3	8200 ± 900	5100 ± 900	83.5 ± 6	13700 ± 1200	27.2 ± 2.0	13.6 ± 1.0
14	CN 4	9600 ± 900	8200 ± 900	92.6 ± 8	14300 ± 1100	30.3 ± 2.0	16.4 ± 1.1
15	CN 5	9900 ± 900	7900 ± 900	53.9 ± 4	10400 ± 1100	21.5 ± 1.1	11.4 ± 0.9
<b>Average</b>		<b>8840</b>	<b>7000</b>	<b>73.78</b>	<b>12640</b>	<b>25.38</b>	<b>13.58</b>

## II. Pb-210 sediment dating

### *Sample preparation*

The sediment column was separated in to 15 sediment slice. Sediment samples were dried to constant weight at 70°C. After passing the 2mm sieve, all samples were prepared as a fine homogeneous powder by grinding. For gamma counting, this powder was cast using polyester resin in one of two moulds of 54 cm<sup>3</sup> (disk geometry) and 238 cm<sup>3</sup> (cup geometry) with the maximum sample proportion of about 70%. This gives mineral sample weights of about 50g and 300g, respectively. In preparation of sample for alpha counting in the analysis of <sup>210</sup>Po, samples were dissolved by wet acid digestion procedures. Polonium was extracted with 0.1% DDTC in chloroform from HCl solution and then deposited on silver (see Martin, P. and Hancock, G. 1992). <sup>209</sup>Po was used as a tracer in the chemical separation.

### Analysis of radioactivity

Sediment samples were measured for  $^{226}\text{Ra}$  and  $^{137}\text{Cs}$  by using a 30% p-type intrinsic germanium detector in a vertical slimline cryostat assembly.  $^{226}\text{Ra}$  was measured by the 295keV, 352keV and 609keV gamma rays emitted by its daughters. Radionuclide  $^{137}\text{Cs}$  was measured by its gamma emission at 662keV. The content of  $^{210}\text{Pb}$  was determined through its daughter radionuclide  $^{210}\text{Po}$  with the assumption of secular equilibrium. Radionuclide  $^{210}\text{Po}$  was analyzed using silicon surface-barrier detectors with 600mm<sup>2</sup> active area. Unsupported  $^{210}\text{Pb}$  then was calculated by subtraction of  $^{210}\text{Pb}$  supported by the parent  $^{226}\text{Ra}$  from the total  $^{210}\text{Pb}$  activity. In most situations the supported  $^{210}\text{Pb}$  could be assumed to be in radioactive equilibrium with the *in situ*  $^{226}\text{Ra}$ .

### Dating sediment

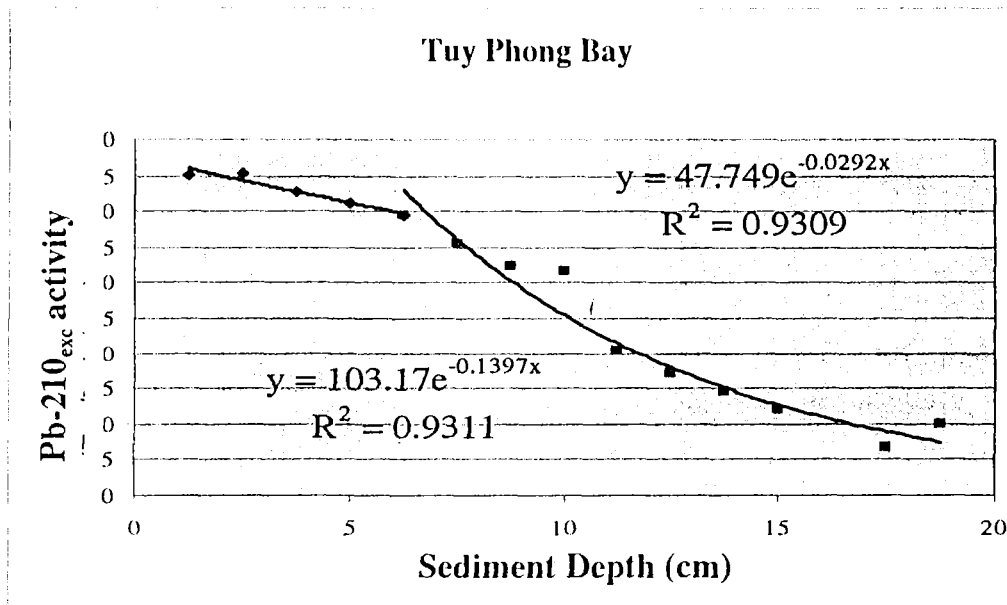
Set window ruler Radioisotope  $^{210}\text{Pb}$  was principally used for dating. The CIC (Constant Initial Concentration of  $^{210}\text{Pb}$  excess) model was commonly utilized for calculating sediment dates (see Appleby & Oldfield 1978 for further details).  $^{137}\text{Cs}$  was also employed when the technique is applicable.

### Results

Sediment deposition rate at sampling site using Pb-210 technique is 0.38 cm/y (see figure) in Tuy Phong Bay.

**Table 2:** Alpha Measurement for Tuy Phong Bay sediment

Depth (cm)	Pb-210exc (Bq/kg)	Abs error	Years of sediment (year)	Sediment deposition rate (cm/y)
1.25	45.18	3.43		
2.50	45.48	3.37	2.34	1.61
3.75	42.86	3.20	3.50	1.08
5.00	41.22	3.32	4.67	1.06
6.25	39.55	2.71	5.84	1.03
7.50	35.56	2.76	13.74	0.62
8.75	32.50	2.28	23.03	0.58
10.00	31.76	2.40	26.32	0.63
11.25	20.47	2.39	29.61	0.38
12.50	17.24	1.85	32.89	0.35
13.75	14.55	1.89	36.18	0.34
15.00	12.14	2.15	39.47	0.32
16.25	10.23	2.59	42.76	0.31
17.50	6.71	2.00	46.05	0.27
18.75	9.89	2.26	49.34	0.35



### III. The preliminary results of studying on dinoflagellate cysts in Tuy Phong Bay

Tuy Phong Bay is located in the Central Viet Nam (11°15N and 108°45E) belonging to Binh Thuan province. Every year, there have many activities such as forest destroy... nearby the bay have also affected negatively on the marine environment of this area. The monitoring results belonging to National Marine Observation Stations in Tuy Phong Bay showed that the nutrients and plankton biomass especially the diatoms are usually higher than the other stations. Some potentially harmful microalgae including diatoms (*Pseudo nitzschia* spp.) and dinoflagellates (*Alexandrium* spp., *Dinophysis* spp. etc.) have been found in the area. To contribute for understanding the historical blooming of microalgae in Tuy Phong Bay a studying on cysts in sediment have been carried out in 2003. This work is a part of the project on “Applied nuclear technique on study of harmful algal blooms” supported by MOSTE (Ministry of Science, Technology and Environment of Viet Nam) running by cooperation between Dalat Nuclear Research Institute and Nhatrang Institute of Oceanology.

#### Materials and Methods

Including the sediment samples collected in July 2002 by diver using SCUBA equipment. The plankton samples in water column were sampled at the same time. The sediment cores of 20 – 30cm were sliced into every 2cm for sub-samples. Methods for processing sediment samples in the laboratory were following Matsuoka and Fukuyo (2000). Cyst observation was carried out under OLYMPUS BX 51 microscope with OLYMPUS DP-12 digital camera accessories. The literatures such as Matsuoka (1985), Matsuoka and Fukuyo (2000), dinoflagellate cyst figure plates of IOC/WESTPAC-HAB were used as the main references for cyst identification.

## Results

### *Cyst composition in sediment of Tuy Phong Bay*

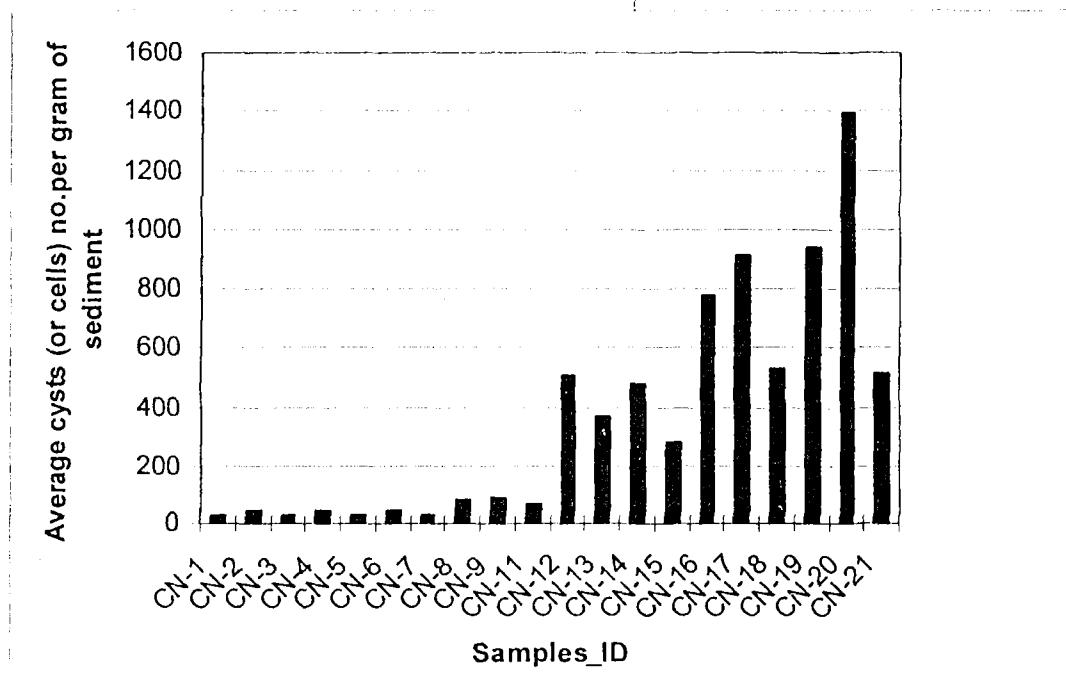
A total of 129 types of dinoflagellate cysts belonging to different species have been found in the Tuy Phong Bay which were listed in Table 1. and illustrated in the Plates from 1 to 21. In general, the cyst composition in the studied area is rather diverse although some types of cyst were not identified in detailed due to lacking references. The analyzing results showed that the most common cysts were belonged to *Protoperidinium* genus (about 12 *Gonyaulax* digital is 14 *protoperidinium*). The rest genera such as *Gonyaulax*, *Alexandrium*, *Zygabikodinium*, *Pheopolykrikos*, *Gymnodinium* etc. consisted of only one or a few types of cyst. However, it is very difficult to list the dinoflagellate species produced cyst in studied area in detailed so far. Because one species may contain several types of cyst depending on the stages of cyst development. To do this we need to make the cultures from natural cysts.

The quantitative distribution of cyst in sediment of Tuy Phong Bay was presented in the below figure. In general, the average numbers of cyst in the sub-samples of sediment core were lower than 46 cysts per wet sediment gram including 17 in the total of 21 sub-samples (occupied about 81%). There were 3 sub-samples ranged about 65 – 80 cysts/gr. Two sub-samples CN-13 and CN-15 have number of cysts about 283 to 369 cysts/gr. Based on cyst study, it was obvious that there had some dinoflagellate blooms which produced cysts in the past.

**Table 3:** Distrubition of cyst in sediment core

Order	Sample_ID	Number of cyst types
1	CN-1	25
2	CN-2	44.1
3	CN-3	29.7
4	CN-4	45.7
5	CN-5	26
6	CN-6	43.5
7	CN-7	27.2
8	CN-8	81
9	CN-9	82.4
10	CN-11	64.8
11	CN-12	508.7
12	CN-13	368.5
13	CN-14	482.8
14	CN-15	282.7
15	CN-16	780.6

16	CN-17	915.7
17	CN-18	528.4
18	CN-19	942.9
19	CN-20	1398.2
20	CN-21	519.1



**Figure:** Distribution of cysts in sediment in Tuy Phong Bay

### Recommendation

This is only preliminary result of study on dinoflagellate cyst in Tuy Phong Bay. Due to the lacking of references and experiences in this field in Vietnam so many cysts were not identified in detailed. The training for cyst analysis will be very necessary for us in the near future.

### REFERENCES

1. Fukuyo Yasuwo, Takano Hideaki, Chihara Mitsuo and Matsuoka Kazumi (eds.) (1990). Red tide organisms in Japan – An illustrated taxonomic guide. 430 pp., Uchida Rokakuko, Tokyo, Japan.
2. Matsuoka Kazumi (1985). Organic-walled dinoflagellate cysts from surface sediments of Nagasaki Bay and Senzaki Bay, West Japan. Bull. Faculty of Liberal Arts, Nagasaki Univ., (Natural Science), 25(2): 21-115.
3. Matsuoka Kazumi and Fukuyo Yasuwo (2000). Technical guide for modern dinoflagellate cyst study. WESTPAC-HAB/WESTPAC/IOC.
4. Project review meeting on Nuclear Techniques to Address Hab Concerns, Bangi, Malaysia, March, 2003.