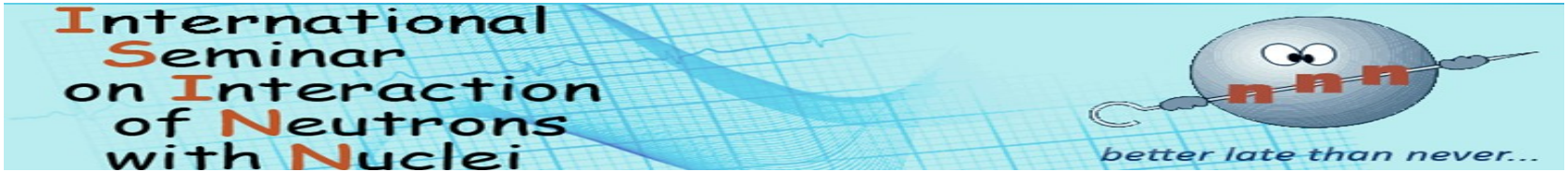

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DALAT NUCLEAR RESEARCH INSTITUTE

TRITIUM ACTIVITY CONCENTRATION STUDY IN SEAWATER SAMPLES IN THE GULF OF TONKIN, VIETNAM

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02 Sampling and Method

03 Results and discussions

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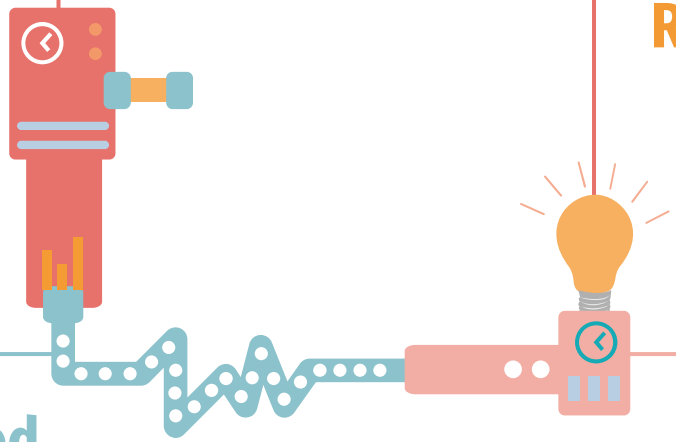
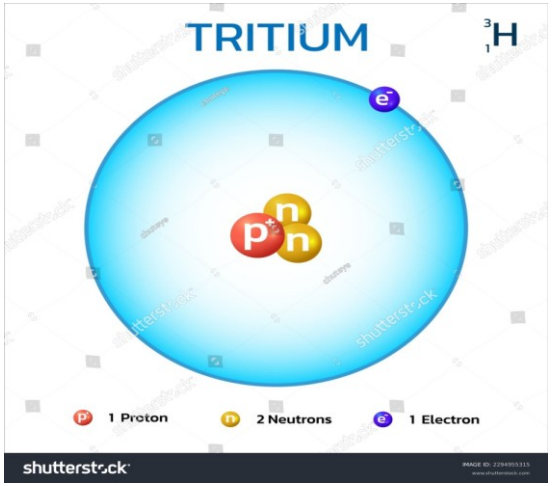


1. Introduction

Characteristics of ^{3}H

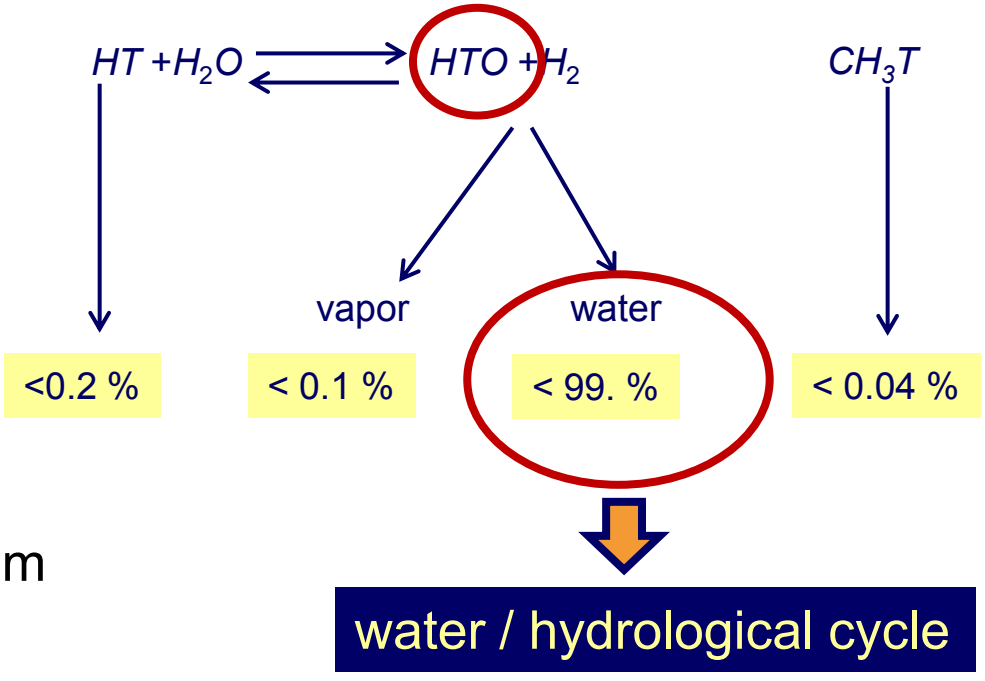


Chemical

Tritiated water (**HTO)**

Gaseous tritium (**HT)**

Organically bound tritium (**OBT)**

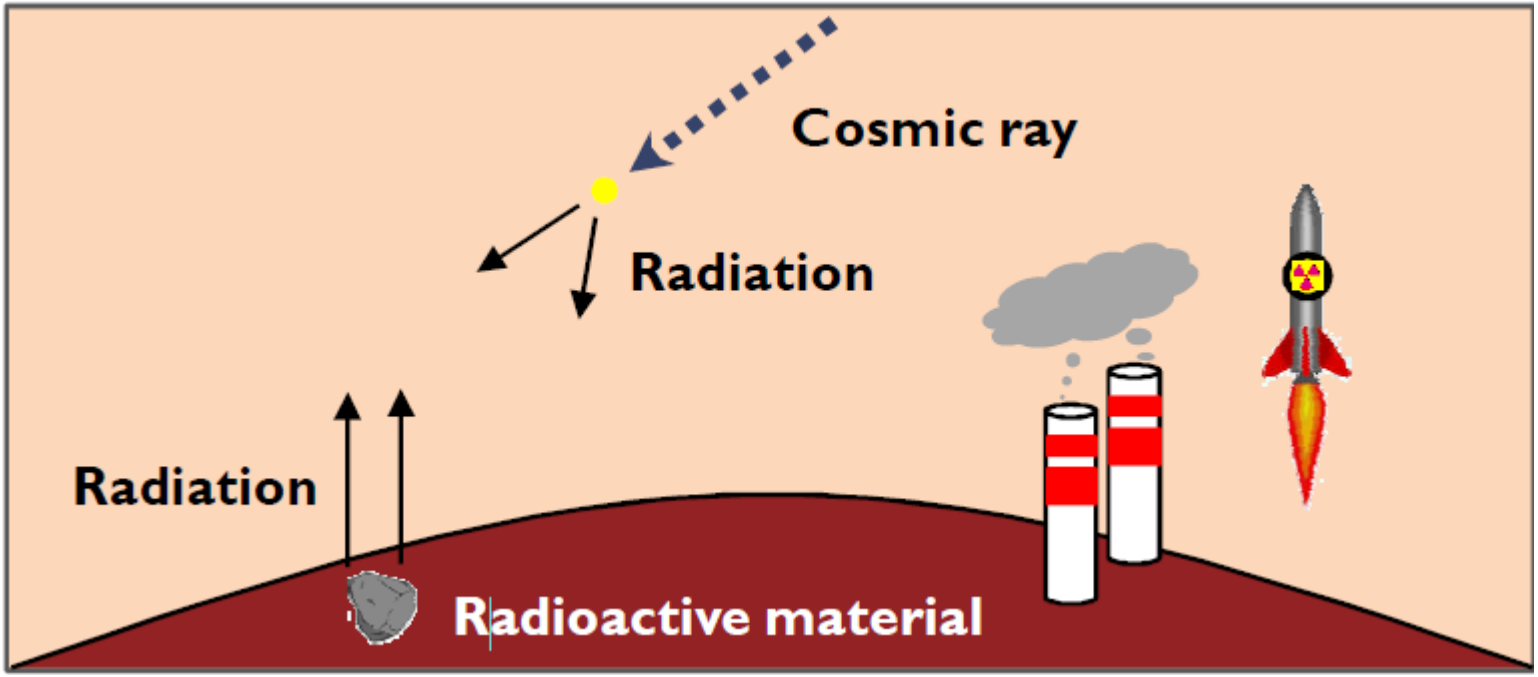


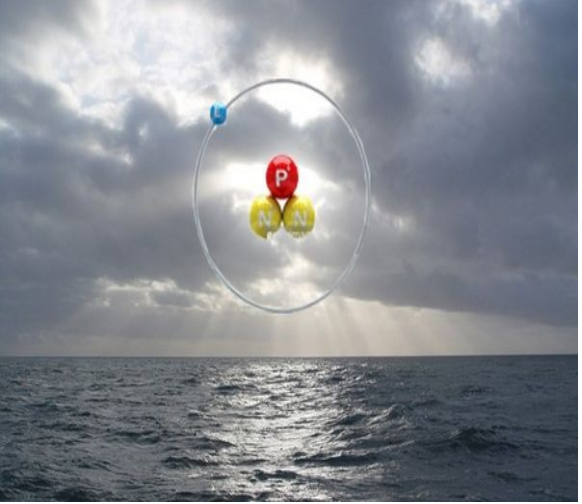
Characteristics of ^{3}H

Nuclear

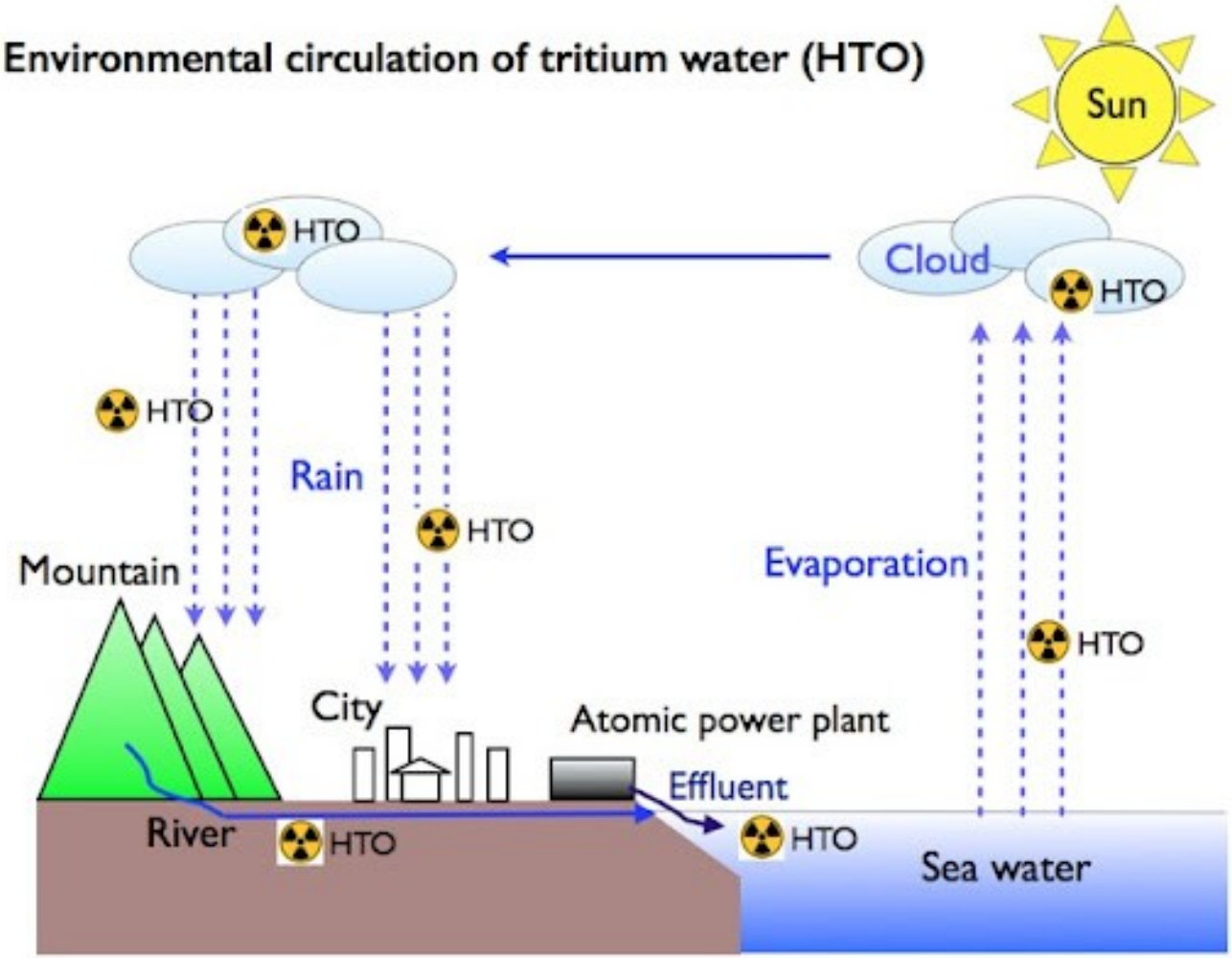
- Half-life $t_{1/2}$: 12.312 years
- Specific activity: 3.56 x 10^{14} $Bq.g^{-1}$
- Decay product: ^{3}He
- β- 18.6 keV (100%)


TRITIUM


Cosmic ray
Radiation
Radiation
Radioactive material



Environmental circulation of tritium water (HTO)



Method for determination of Tritium

Method	Advantages	Disadvantages
Ultra fast IR spectrometry	Vibrational spectrometry	High concentrations only
Sample Qxidation method	Rapid, diverse samples, Good recovery, no quench, small sample	Inital investment, gas supply, fume hood
GPC (gas propotional)	Sensitive, high precision	Not energy dependent, low counting efficiency, complex procedure, large sample
LSC direct	**Relatively fast**	**Quench**
LSC after enrichment	**Sensitive**	**Inital investment, work intensive, large sample, slow**
MS – ^{3}He in-growth	very sensitive, small volume sample	Extremly long (time for in-growth), expensive

2. Sampling and methods

Sampling

Sampling location	Sampling time	Sample code	Remarks
Tra Co town – Quang Ninh Province	December 2018 February 2019 June 2019 October 2019 June 2020 October 2020	**STC1218** **STC0219** **STC0619** **STC1019** **BTC0619** **STC1019**	~5 km from the Vietnam shore ~50 km from Fangchenggang Nuclear Power Plant (China)
Bach Long Vi Island – Hai Phong Province	December 2018 February 2019 June 2019 October 2019 June 2020 October 2020	**SBL1218** **SBL0219** **SBL0619** **SBL1019** **SBL0619** **SBL1019**	~5 km from the island, ~120 km from the Vietnam shore ~170 km from Fangchenggang Nuclear Power Plant (China) ~140 km from Changjiang Nuclear Power Plant (China)
Ky Anh town – Ha Tinh Province	December 2018 February 2019 June 2019 October 2019 June 2020 October 2020	**SKA1218** **SKA0219** **SKA0619** **SKA1019** **SKA0619** **SKA1019**	~5 km from the Vietnam shore ~295 km from Changjiang Nuclear Power Plant (China)

Sampling

- Seawater were collected approximately 5 km offshore.
- The sampling sites were reached by boat, and an electric pump was used to collect seawater from a depth of approximately 1 m.
- Glass bottles were used, and each bottle was tightly sealed with a cap, clearly labeled, and returned to the laboratory for analysis.

Method of analysis

1st distillation

Change of conductivity

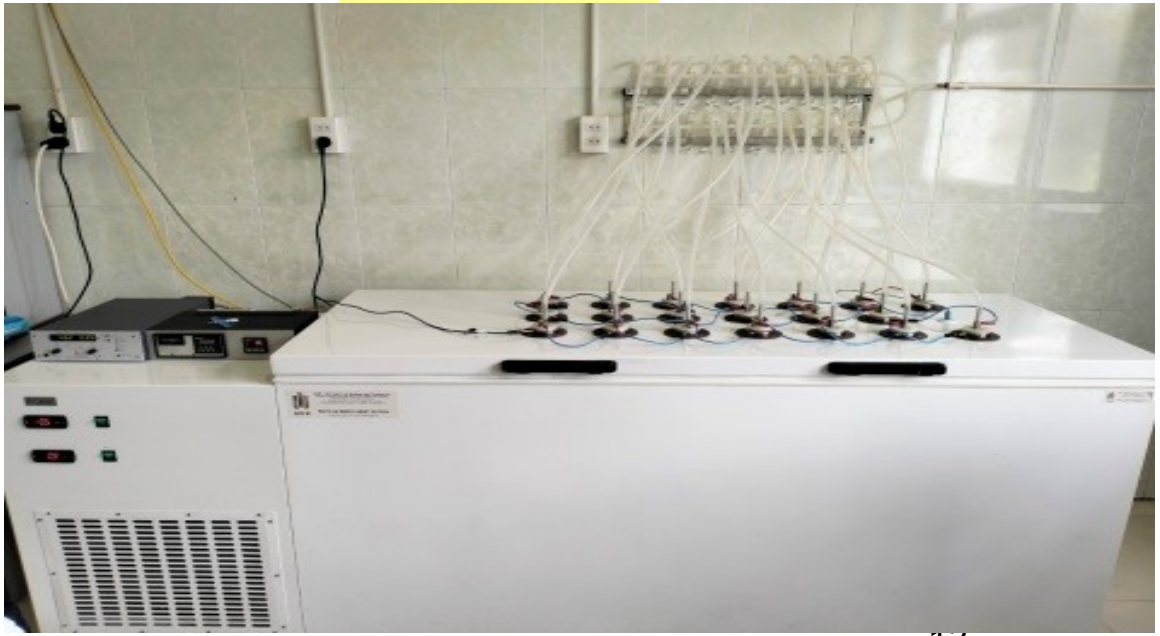
Method of analysis

1st distillation

Change of conductivity

electrolytic enrichment

Tritium enrichment system of AGH University of Science and Technology, Krakow, Poland



Method of analysis

1st distillation

Change of conductivity

electrolytic enrichment

neutralization

Method of analysis

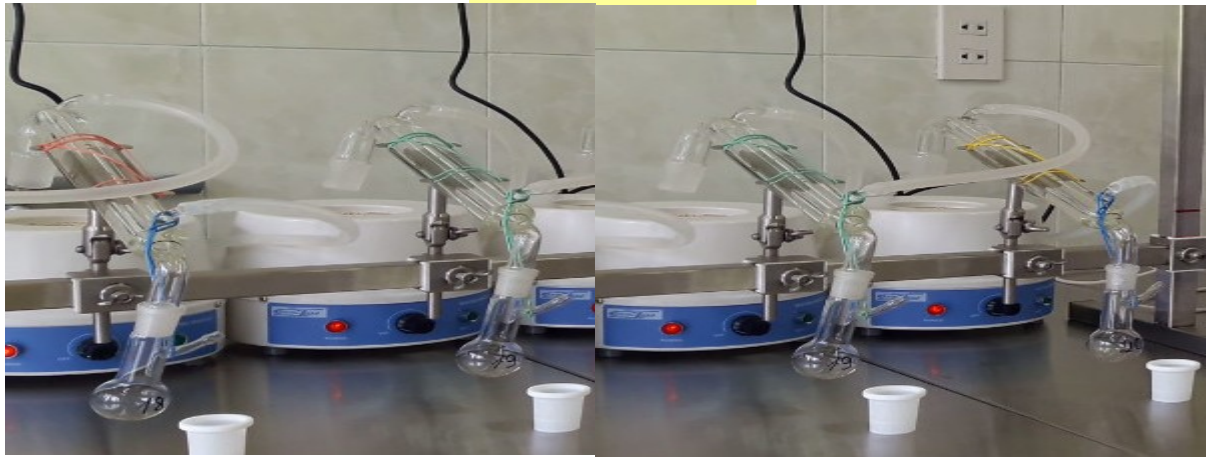
1st distillation

Change of conductivity

electrolytic enrichment

neutralization

2nd distillation



Method of analysis

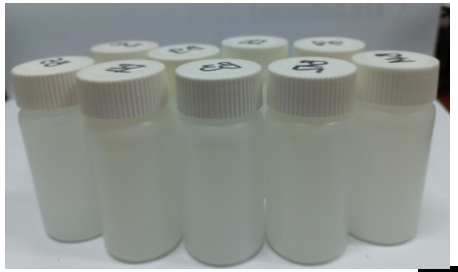
1st distillation

Change of conductivity

electrolytic enrichment

neutralization

2nd distillation

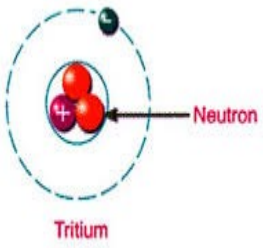


measurand preparation

Liquid scintillation counting

LSC system, Tri-carb 3180TR/S

Method of analysis



The concentration activity of tritium in each sample at the counting time is calculated using the following formula:

$$A_T = \frac{N_{SA} \cdot A_{ST}}{N_{ST} \cdot E_S} \qquad (1)$$

A_T: tritium content in the given sample

N_{SA}: net count rate of the sample (cpm)

N_{ST}: net count rate of the standard (cpm)

A_{ST}: tritium activity in the standard on the counting date (TU)

E_T: enrichment factor for the given sample

Quality assessment of the method

Environmental Radioactivity Analysis and Monitoring
Department, Center for Environment Research and Monitoring
Dalat Nuclear Research Institute

Proficiency Test IAEA–RML–2019–01

Proficiency Test IAEA–RML–2020–01

3. Results and Discussion

Quality assessment of the method

Results were analyzed using different statistical evaluation as accuracy, precision and trueness based on IAEA criteria as follow:

Accuracy: $\text{Value}_{analyst} = \frac{\text{Value}_{analyst} - \text{Valuet}_{target}}{\text{Valuet}_{target}} \times 100$

The absolute value of the relative bias was compared to the Maximal Accepted Relative Bias (MARB).

The precision (P) $\sqrt{\left(\frac{unc_{target}}{\text{Valuet}_{target}}\right)^2 + \left(\frac{unc_{analyst}}{\text{Value}_{analyst}}\right)^2} \times 100$

The precision P was compared to the Limit of Accepted Precision (LAP).

The results for trueness was compared to $\frac{\text{Value}_{analyst}}{\text{Valuet}_{target}} 2.58P$

Bias relative: -1.3-7.5% below the accepted value

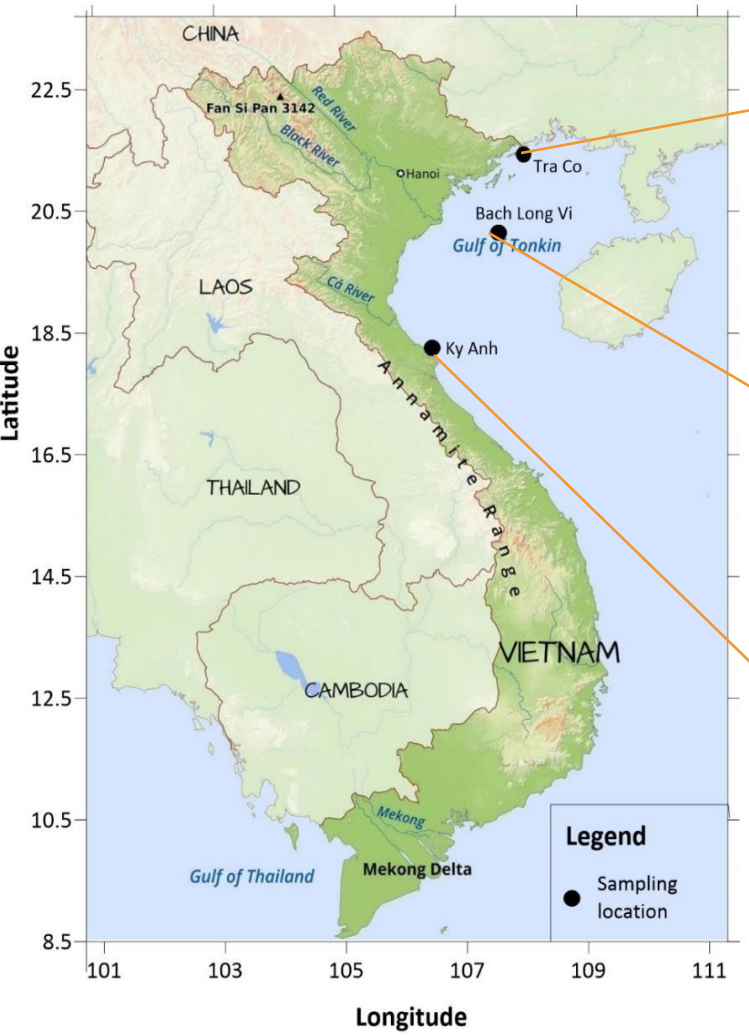
The *MARB* and *LAP* values : 25% for ^{3}H.

⇒ *The results passed accuracy, precision, and trueness criteria based on IAEA criteria*

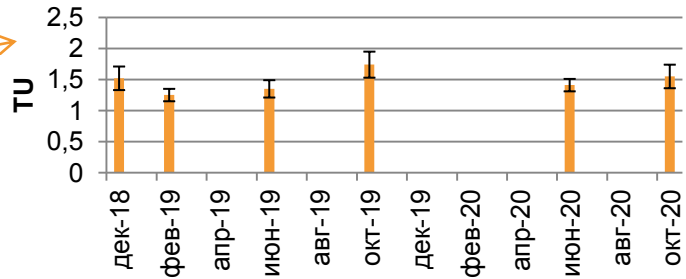
Tritium in seawater samples

Sampling location	Sampling time	Sample code	TU	Bq/L
Tra Co town – Quang Ninh Province	Dec-18	STC1218	1.52 ± 0.19	0.18 ± 0.02
	Feb-19	STC0219	1.25 ± 0.1	0.15 ±0.01
	Jun-19	STC0619	1.35 ± 0.14	0.16 ± 0.02
	Oct-19	STC1019	1.74 ± 0.21	0.21 ± 0.03
	Jun-20	BTC0619	1.41 ± 0.1	0.17 ± 0.01
	Oct-20	STC1019	1.55 ± 0.19	0.18 ± 0.02
	Average ± SD		***1.47 ± 0.18***	***0.17 ± 0.02***
Bach Long Vi Island – Hai Phong Province	Dec-18	SBL1218	1.44 ± 0.18	0.17 ± 0.02
	Feb-19	SBL0219	1.65 ± 0.2	0.20 ± 0.02
	Jun-19	SBL0619	1.53 ± 0.21	0.18 ± 0.03
	Oct-19	SBL1019	1.24 ± 0.14	0.15 ± 0.02
	Jun-20	SBL0619	1.52 ± 0.12	0.18 ± 0.01
	Oct-20	SBL1019	1.12 ± 0.09	0.13 ± 0.01
	Average ± SD		***1.42 ± 0.21***	***0.17 ± 0.02***
Ky Anh town – Ha Tinh Province	Dec-18	SKA1218	1.47 ± 0.2	0.17 ± 0.02
	Feb-19	SKA0219	1.03 ± 0.17	0.12 ± 0.02
	Jun-19	SKA0619	1.23 ± 0.19	0.15± 0.02
	Oct-19	SKA1019	1.2 ± 0.19	0.14 ± 0.02
	Jun-20	SKA0619	1.04 ± 0.06	0.12 ± 0.01
	Oct-20	SKA1019	0.99 ± 0.07	0.12 ± 0.01
	Average ± SD		***1.16 ± 0.19***	***0.14 ± 0.02***

The activity concentration of ^{3}H in seawater in the Gulf of Tonkin ranged from **0.99 ÷ 1.74 TU (0.12 ÷ 0.21 Bq/L)** with average values of **1.35 TU (0.16 Bq/L)**

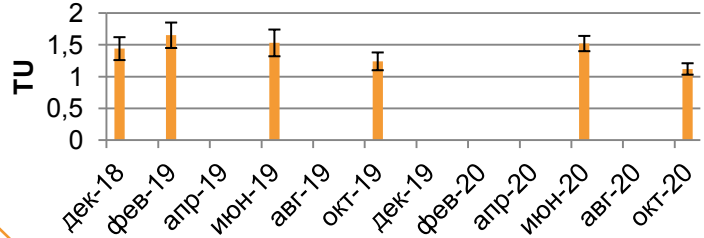


Tra Co



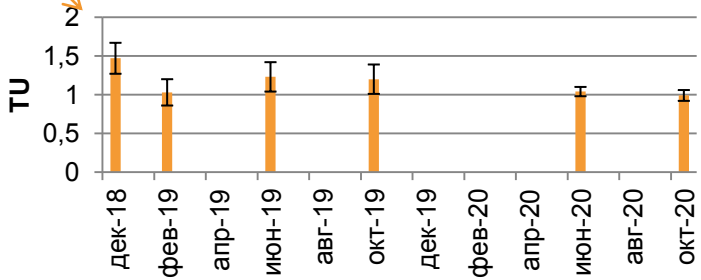
1.25 ÷ 1.74 TU
(0.15 ÷ 0.21 Bq/L)
average 1.47 TU
(0.17 Bq/L)

Bach Long Vi



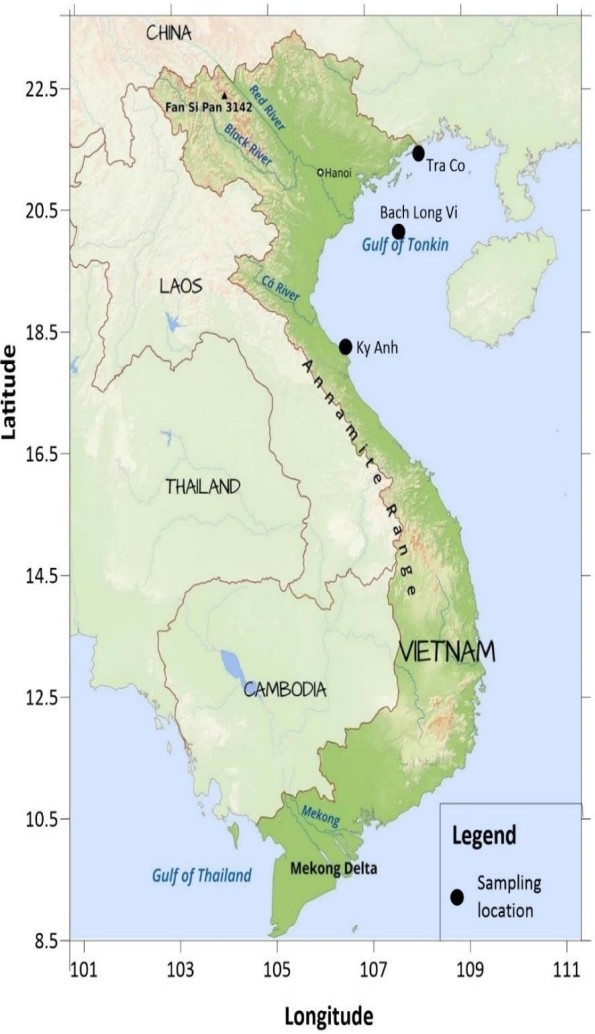
1.12 ÷ 1.65 TU
(0.13 ÷ 0.20 Bq/L)
average 1.42 TU
(0.17 Bq/L)

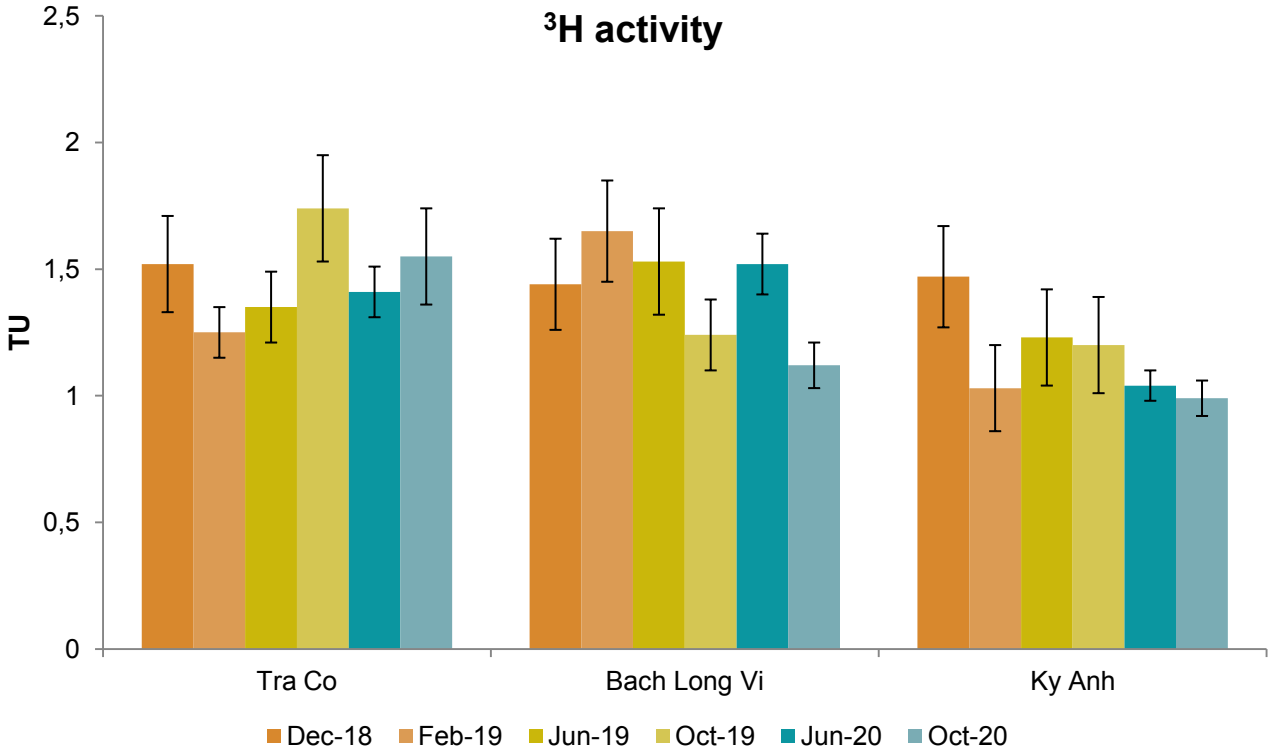
Ky Anh



0.99 ÷ 1.47 TU
(0.15 ÷ 0.21 Bq/L)
average 1.16 TU
(0.14 Bq/L)

Tritium in seawater samples





Variability of the radioactivity of ^{3}H in seawater at monitoring sites

Tritium in seawater samples

^{3}H activity (TU)	The present study	The Gulf of Tonkin, Vietnam [13]	Asia - Pacific region [14]
Seawater	0.99 ÷ 1.74	1.31 ± 0.15	0.4 ÷ 1.30

4. CONCLUSIONS

4. CONCLUSIONS

1

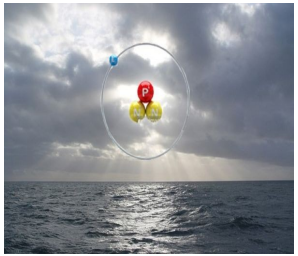
This work presents measurements of the activity concentration of Tritium in seawater in the Gulf of Tonkin, using electrolytic enrichment LSC. The procedure was validated by accuracy, precision, and trueness through the analysis of proficiency test samples organized by IAEA.

2

The activity concentration of ^{3}H in seawater in the Gulf of Tonkin ranged from 0.99 ÷ 1.74 TU (0.12 ÷ 0.21 Bq/L) with average values of 1.35 TU (0.16 Bq/L). The results were in correspondence with the value range of other studies in Vietnam and Asia–Pacific.

$\Rightarrow$ These values show that the ^{3}H radioactivity in seawater is low and mainly generated from natural processes through fallout.

$\Rightarrow$ The values can be considered as background values to assess environmental impacts from nuclear activities around the Gulf of Tonkin in subsequent studies.



REFERENCES

1. Report prepared for the CNSC by ECOMETRIX Incorporated in association with RWDI Air Inc. (RSP-0247). Investigation of the Environmental Fate of Tritium in the Atmosphere, March 2009.
2. http://www.lnhb.fr/en/
3. Tetsuo Tanabe Editor, Tritium: Fuel of Fusion Reactors, Springer 2017.
4. Report prepared for the CNSC by ECOMETRIX Incorporated in association with RWDI Air Inc. (RSP-0247). Investigation of the Environmental Fate of Tritium in the Atmosphere, March 2009.
5. Feng B, Chen B, Zhao C, He LF, Tang FD, Zhuo WH (2020). Application of a liquid scintillation system with 100-ml counting vials for environmental tritium determination: procedure optimization, performance test, and uncertainty analysis. J Environ Radioact 225:106427
6. Normile, D. The Trouble with Tritium. Science 2014, 346, 1278. DOI: 10.1126/science.346.6215.1278
7. Radiological Protection Institute of Ireland “A survey of tritium in Irish seawater”, 2013.
8. Jin-long Lai, Zhan-guo Li, Yi Wang, Hai-ling Xi, and Xue-gang Luo. Tritium and Carbon-14 Contamination Reshaping the Microbial Community Structure, Metabolic Network, and Element Cycle in the Seawater Environment, Environmental Science & Technology. 2023, 57, 13, 5305–5316. https://doi.org/10.1021/acs.est.3c00422
9. Oms PE, du Bois PB, Dumas F, Lazure P, Morillon M, Voiseux C, Le Corre C, Cossonnet C, Solier L, Morin P (2019) Inventory and distribution of tritium in the oceans in 2016. Sci Total Environ 656:1289–1303
10. Povinec PP, Lee SH, Kwong LLW, Oregioni B, Jull AJT, Kieser WE, Morgenstern U, Top Z (2010) Tritium, radiocarbon, 90Sr and 129I in the Pacific and Indian Oceans. Nucl Instrum Meth B 268:1214–1218
11. Tong Zhang, Huan Jiang, Ning Chen, Yongchang Wang, Mengting Zhang, Xiaolin Hou. Determination of tritium in large volume of seawater using electrolytic enrichment and LSC and its application for the East China Sea water, Journal of Radioanalytical and Nuclear Chemistry. https://doi.org/10.1007/s10967-022-08752-w
12. Nguyen Quang Long (2017). Report summarizing the ministerial-level task on: "Determining the radioactivity of artificial radioactive isotope Cs at a point in the marine environment of Northern Vietnam from the FUKUSHIMA nuclear power plant incident".
13. IAEA/RCA/UNDP Project, Asia-Pacific marine radioactivity database (ASPAMARD), http://aspamard.pnri.dost.gov.ph/home.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