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IDENTIFICATION OF THE KINDS AND COMPOSITIONS OF RADIOISOTOPE AND OTHER ELEMENTS WITHIN THE MINERAL SAMPLES USING MULTICHANNEL ANALYZER (DIGITAL SPECTRUM ANALYSIS) AND NEUTRON ACTIVATION ANALYSIS AT SUBDISTRICT OF AMARASI, KUPANG WEST TIMOR ISLAND INDONESIA

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ABSTRACT

The problems analyzed in this research are the kinds and compositions of radioisotope and other elements within the mineral samples in the West Timor Island. The purposes of the research: 1) to investigate and determine the kinds of radioisotope in the mineral sample, 2) to determine radiation energy, counts, half-life, and percentage of radioisotope content in the mineral sample, 3) to investigate other elements in mineral sample. The methods of the research include observation, survey, sampling, spectrometry, analysis, and interpretation. On the observation, survey, and sampling steps, the 50 samples taken are distributed at the survey location. Those samples are analyzed with the several steps including: drying samples, refining, burning until temperature 800^o C, stabilization and drying again. All samples are analyzed with spectrometry system on the multichannel analyzer (MCA) which can separate element of the samples. The other elements (only non- radioactive samples) are analyzed by neutron activation analysis with steps comprise of: 1) the dust and standard samples are balanced 0.50 grams up to 1.00 grams and put into the poliethilene capsule and irradiated during three hours in research reactor (Hoger Onderwijs Reactor with MTR-fuel assemblies and low enriched U-235: <20%) with the same time. After irradiation finished, the field and standard samples are refrigerated during one week, so the all samples with short half-life decay finished. Furthermore, the samples are analyzed by gamma spectrometry for determining the other elements in mineral samples. The results obtained are the kinds of radioisotope content within the mineral samples consist of Actinium series 50%, Uranium 25%, and Thorium 25% component and other association elements, also energy radiation, counts, half-life, and percentage of radioisotope content within the mini sample respectively revolved between 26.6 keV up to 1562.3 keV,1 cps up to 24867cps, 3.16 minutes up to 1.405 x 10^{10} years, and 0.19% up to 99.00%. The main elements on Actinium series within the samples of mine comprise of U-235, Th-231, Pa-231, Th-227, Bi-211, and Rn-219, and other isotopes Bi-212, Th-232, Pb-212, Pa-234, Ac-228, Ra-226, and Pb-214, with energy radiation, counts, half-life, and percentage of radioisotope element deposit respectively revolved between 26.6 keV up to 426.9 keV, 1 cps up to 24867 cps, 7.038 x 10^8 years up to 1.405 x 10^{10} years, and 1.0% up to 18.7 %.The association elements consist of Am-241, Cs-134, Cs-136, Cs-138, Ce-141, Ce-144, Ba-133, Ba-140, Cd-109, Se-75, Te-132, Co-57, Mo-99, Kr-85, Kr-88, Kr-89, Sb-122, Sb-124, Sb-125, Xe-125, Xe-135, Xe-138, I-124, I-125, I-130, I-131, I-132, I-134, I135, Br-82, Y-92, Y-93, Y-94, W-187, Sr-91, Sr-92, Sr-93, Rb-89, Rh-105, Sn-133, Nb-94, Nb-96, Nb-97, Cr-51, Eu-152, and Tc-96. The other elements are detected by neutron activation analysis consist of: Fe-59, Xe-133m, Xe-135m, Y-91m, Zr-97, Ni-65, Be-7, Ag-110m, As-76, Cr-52, Au-198, and Ca-21.

Keywords: *analysis; kind; composition; radioisotope; mineral*

PENDAHULUAN

The territory or area is located in Nusa Tenggara Timur Indonesia, visible barren if it is inspected or seen spontaneously, however when the area is investigated carefully, we can

see that the area is rich with the various minerals which have the high economic value.

On observation and pre survey, it appears that at Nusa Tenggara Timur Indonesia there are several natural radioisotope sources, which are still hidden or buried within the minerals. It is not yet investigated carefully. The symptom on the land surface show that, at Flores Island Ngada and Larantuka, and at West Timor Island there are distribution of natural radioisotope contents which are very large. That is estimated or presumed that the contents of radioisotope at those places are prospect enable for exploration to support the development rate of region specially and nationally general.

Pre survey have been generally done to give description or image that the distribution of radioisotope contents within the mineral samples in the West Timor Island, a large part at Sub-district of Amarasi, Kupang, It is started from West Kupang and spread out to east direction through a part of Middle Kupang, Amarasi, until to a part of East Kupang with the distance 35 km approximately. On the pre survey at Oesuu village Sub-district of Amarasi West Timor Island is obtained the result that the distribution of radioisotope there are on the area around 12 kilometers cross 15 kilometers with the area which some time dangerous is around 2 kilometers x 3 kilometers squares [1]. The composition of lands constitutes the *aluvial* and *coluvial* area those are formed from sedimentary rocks because compression of the highest pressure and corrosion, and other part of this area are *metasediment* rocks.

The neutron activation analysis of radioisotope concentration on several samples citation at the area on pre survey give the result range between 2 ppm to 27 ppm [2].That result assumption that the minerals in the West Timor Island Nusa Tenggara Timur Indonesia, contents prospect of radioisotope.

Based on observation and pre survey result in the West Timor Island Nusa Tenggara Timur Indonesia, the researcher wishes to study or investigate and express clearly about the kind or various element, half life, counts, percent of atom residue after decay, and radiation energy of radioisotope within mineral samples, as a pre step for exploration.

The main problem studied or investigated in this research is natural radioisotope focused on the kind or various element, half-life, percent of atom residue after decay, and radiation energy of radioisotope within mineral samples.

The problems specification will be studied or researched consist of: the kind or various of radioisotope, half-life percent of atom residue after decay, and radiation energy.

The general aims of this research comprise of: to study or investigate of radioisotope contents and other elements within mineral sample. The specific aims are studied on this research consist of: to investigate and determine the kinds of radioisotope, half-life, radiation energy, and percent of atom residue after decay, composition, and investigate other elements within mineral sample in the West Timor Island NTT.

Composition of Mineral which distribute of Radioisotope

The layer composition of the earth's crust consists of the earth's outer crust, cover, and mantle which can be characterized of solid, liquid, and gas. Solid material is called rocks in composition of minerals. Based on theirs formed, the rocks consist of: igneous rocks, sedimentary rocks, and metamorphic rocks. The composition of rocks on the earth surface, in general are dominated by sedimentary rocks 66% approximately on the surface, extrusion rocks 8%, intrusion rocks 9%, and metamorphic rocks 17%[3].

In composition of rocks contained of natural radioisotope which are present do simultaneously with forming of the earth and universe. The primordial radionuclide which have been present do simultaneously with forming of the earth and rocks, in general consists of Potassium-40 and a row of nuclide as product of radionuclide decay occur in natural like as series of Uranium (4n+2), Thorium (4n), and Actinium (4n+3). The other primordial radionuclide is found in natural include Rb-87, La-136, Lu-176, Ln-115, Re-187, and C-14 [3].

[4]give expression that the abundance of radioisotope like as Potassium, Thorium, and Uranium can be found within the several kinds of rocks like as Meteorites, Terrestrial that consist of Olivine-Hornblende, Plagioclase (Granite), and Basalt.

Another that, Langford proposes that the accumulation of radioisotope like as Uranium, there are within several minerals like as Pegmatites, Carnotite, *Tazin* Gneiss [5].

The research result from Hanson et al give the report that the anomaly of radioisotope contents, is accumulated at the *aluvial* area that rich of Granite, Carnotite, Tyuyamunite, Asphaltic Sandstones, Moccasin Creek Gypsum, Carbonate, and generally in sedimentary rocks[6].

Accumulation of radioisotope contents within the mineral, physically is influenced by the several factors like as: depth, permeability of rocks, rainfall, flow dynamic, and their's associate with non- radioisotope rocks [7].

Decay of natural Radioisotope.

Radioactivity is an incident that is caused by the changing process in unstable atomic nucleus with processing go on spontaneous. The nucleus stabilization of an atomic is established by combination of proton number and neutron. The stable light in weight element, the ratio N/Z equal to 1.00 and the stable heavy element, N/Z until 1.50. On the changing process N/Z, is accompanied with alpha and beta emission and is followed with gamma emission. The emission event of radiation is added with electron capture is called radioactive decay [8].

The spontaneous change of element can directly produce the stable daughter and can also on series process like as series of Uranium, Thorium, Actinium, and Neptunium.

Initial decay produces direct a stable daughter fulfill equation (Meyerhof, 1989):

$$N = N_o e^{-\lambda t} \text{ ……...…….(1)}$$

Where N is the number of rest atomic after decay in t second time, N_o is the number of initial atomic, t is decay time, and λ is decay constant.

Decay reaction which go on series fulfill an equation [9,8,10,11]:

The series decay until to the second daughter:

$$N_2 = \frac{\lambda_1}{\lambda_2 - \lambda_1} N_1^o (e^{-\lambda_1 t} - e^{-\lambda_2 t}) \text{ ….....(2)}$$

The series decay until to the third daughter:

$$N_3 = N_1^o \left(1 + \frac{\lambda_1}{\lambda_2 - \lambda_1} e^{-\lambda_2 t} - \frac{\lambda_1}{\lambda_2 - \lambda_1} e^{-\lambda_1 t} \right)$$

.....……..……..(3)

The series decay until to the n daughter:

$$N_n = c_1 e^{-\lambda_1 t} + c_2 e^{-\lambda_2 t} + ... + c_n e^{-\lambda_n t} .(4)$$

and activities: $A = \boldsymbol{c}\lambda N$ *or* $A = A_o e^{-\lambda t}$

……..…..……..…….…….....(5)

where: N, N_1, N_2, N_3, and N_n the number of atom after decay on t sec, t_1 sec, t_2 sec, t_3 sec, and t_n sec respectively, t : time, λ, λ_1, λ_2,...., λ_n : decay constants, A : activity of sample after decay on t sec, A_o : initial activity ,and $\boldsymbol{c}$: detection coefficient.

$$c_1 = \frac{\lambda_1 \lambda_2 ..... \lambda_{n-1} N_1^0}{(\lambda_2 - \lambda_1)(\lambda_3 - \lambda_1)(.....)(\lambda_n - \lambda_1)}$$

.....(6)

$$c_2 = \frac{\lambda_1 \lambda_2 ..... \lambda_{n-1} N_1^0}{(\lambda_1 - \lambda_2)(\lambda_3 - \lambda_2)(.....)(\lambda_n - \lambda_2)},$$

etc.....…….....(7)

The methods are used in the research consists of observe / survey, sampling, spectrometry, and analysis. Procedures of the research as follow: 1) to prepare and calibrate equipments necessary, 2) to dry and refine the samples, 3) the samples are filtered and put into the *planset*, 4) the samples are burned until 800^{o}C, so the all samples are changed to the dust. After the samples cold, they are put into the platinum crucible and add distillation water and dry again by hot plate, 5) the last process of samples analyzed on gamma spectrometry with Multichannel Analyzer type (MCA). By using Genie 2000 program which consist of alpha and gamma acquisition and analysis, we obtained the kinds of radioisotope and the quantities of: counts, radiation energy, half-life, percent of atom residue after decay, and also the complete spectrum, 6) interpretation and conclusion. Procedure upon, can be shown clearly on Figure 1. For the other samples are analyzed by neutron activation analysis with steps comprise of: 1) the dust and standard samples are balanced 0.50 grams up to 1.00 grams and put into the *poliethilene* capsule and irradiated during three hours in research reactor (Hoger Onderwijs Reactor with MTR-fuel assemblies and low enriched U-235: <20%) with the same time. After irradiation finished, the field and standard samples are refrigerated during one week, so the all

samples with short half life decay finished. Furthermore, the samples are analyzed by gamma spectrometry for determining the other elements in mine samples.

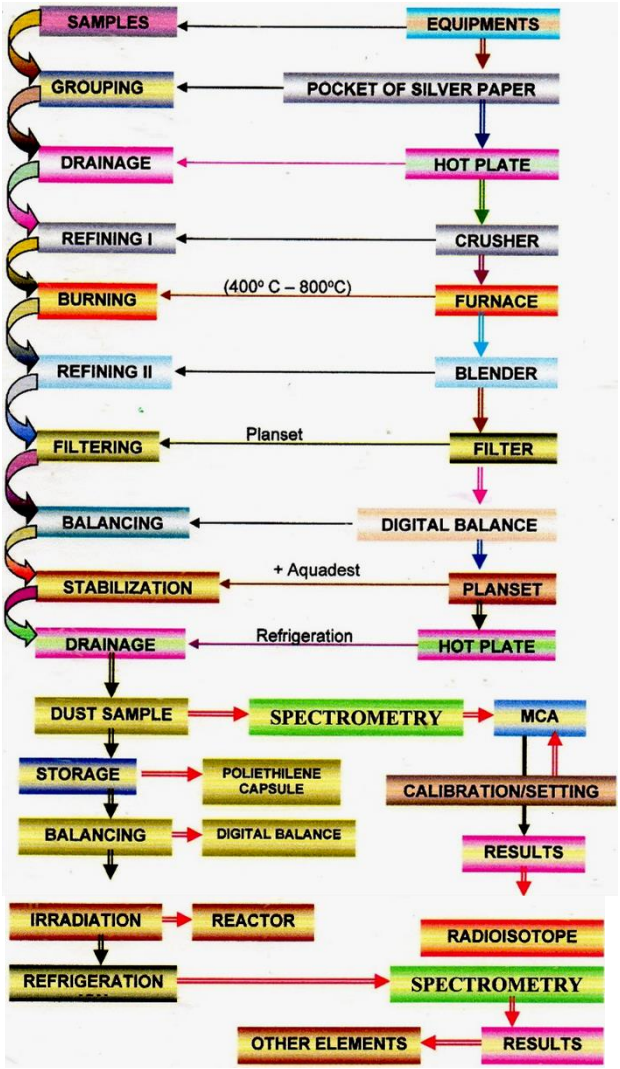

Figure 1. The systematic sketch of Sample Analysis

MCA Setting:Acquire Setup: Live time:1000 s. Comp. Preset: none. **2. Adjust:** 2.1 ADC (Analog to digital converter): * Conversion gain (0 to 1024): 512. * Lower level discriminator threshold (%): setting limits the energy range: 3.44%. * Lower lever discriminator (LLD): 1.18%. * Upper level discriminator (ULD): 1000%. * Zero (%) – Stored in channel 3. * Exit. 2.2 *Stabilyzer* .* Gain Centroid: 521 channel. 2.3 Amplifier: * Coarse gain: x 140, * Input polarity: Positive, * Exit. 2.4 HPVS: *. Status: on. *. Voltage (600-1300) V: 900V. 2.5 Power Manager: * Stand by delay (: ….Min) : 10 min. 2.6 MCS: * Dwell time : 20 ms. * Disc mode: Integral. * ROI start:1 channel, * ROI end: 1024 channel, (ROI: regions of interest). 2.7 Input: * Input name: DSA-2000, * Detector Type: *NaI* Crystal. 2.8 Filter: *

Preamplifier type: RC. * Rise time: 5.6. 2.9 Calibration setup (Menu): * Preferences: Energy Units (eV, keV, MeV, other): keV.

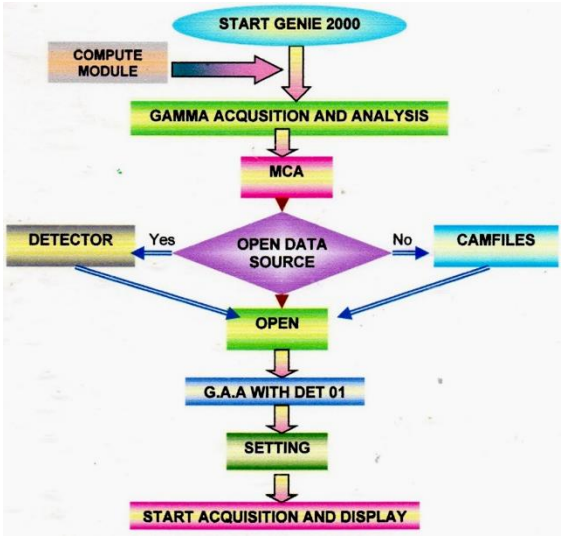

Figure 2. The systematic sketch of Genie 2000 program is operated by MCA and computer system.

* Tolerance units (energy, FWHM): energy.

* Calibration setting: - Tolerance: energy cal: 1.500e +000 keV, eff. match: 1.000e + 000 keV (automatically). - Tail curves: (None, low): low. - Continuum: (step, linear, none): step. * Analysis sequence description: (none, channel): channel. 2.10 Display: * Expand: (on, off, expand spectrum). * Scale: (Manual, auto, linear, log). *. Compare.

DISCUSSION

The results of gamma spectrome-try analysis with multichannel analyzer system for 50 samples of mineral which are taken from radioisotope source at Sub-district of Amarasi, Kupang, West Timor Island, included in the Table 1, and Table 2 as below.

The composition of elements within the mineral samples, a large part is classified in Actinium series (U-235) 50%, Uranium (U-238) 25%, and Thorium (Th) 25% like as in

Table 1 and Table 2 and the others are association elements.

The composition of the elements within the samples of mineral, mineral association possibility comprises of Uraninite (UO_3, UO_2), *Braunnerite* ($UFeO_6$), *Torianite* (ThO_2), *Dumontite* [$Pb_2(UO_2)(PO)_2$. $5H_2O$], Galenite (PbS), *Platnerite* (PbO_2), *Plumboferite* ($PbFe_4O_7$), Gummite [Pb $(UO_2)_2$ *okside*, *Stelsite* ($PbWO_4$), *Masuyite* ($UO_3.2H_2O$ Pb), *Ianthinite* ($2UO_2$. $7H_2O$), *Epiianthinite* (UO_3. $2H_2O$), *Shoepite* (UO_3. $2H_2O$), *Curite* ($Pb_3U_8O_{27}$. $4H_2O$), *Fourmarite* ($PbU_4O_{13}.7H_2O$), *Wolsendorfite* (PbU_2O_7. $2H_2O$), and Clarkeite $(Pb,Th)_2$ $U_2(O,H_2O)_7$. $2H_2O$), and Clarkeite $(Pb,Th)_2U_2(O,H_2O)_7$.

The form of mineral association structure in the rocks can be ascertained through physical and chemical analysis. The number of kinds of elements are deposited within the rock samples in the West Timor are complex.

Table 1. The Composition of elements in Actinium, Uranium, and Thorium series within 50 samples (spectrometry analysis with multi-channel analyzer system)

Series	Half life	Energies range (keV)	Deposit residues range (%)
U-235	7.038 x 10^8 years	90.0., 105.0., 109.1., 143.8.,	1.00., 1.00., 1.50., 10.50.,
		202.1., 205.3	1.00., 4.70
Th-231	7.038 x 10^8 years	26.6., 84.2	18.70., 8.00
Pa-231	7.038 x 10^8 years	27.4., 300.1., 302.7., 330.1	9.30., 2.30., 4.60., 1.30
Th-227	7,038 x 10^8 years	50.2., 94.0., 210.6., 236.0.,	8.50., 1.40., 1.13., 11.20., 6.80.,
		256.3., 286.1., 334.4	1.58., 1.00
Bi-211	7.038 x 10^8 years	72.9., 404.8., 426.9	1.20., 4.10., 1.90
Rn-219	7.038 x 10^8 years	401.8	6.60
Isotope	Half life	Energies revolving (keV)	Deposit residue revolving (%)
Bi-212	1.405 x 10^{10} years	39.9	1.10
Th-232	1.405 x 10^{10} years	59.0	0.19
Pb-212	1.405 x 10^{10} years	74.8., 77.1., 238.6	9.60., 17.50., 44.60
Pa-234	4.468 x 10^9 years	98.4., 131.3., 152.7., 226.9	25.10., 20.00., 7.20., 6.50
Ac-228	1.405 x 10^{10} years	129.1., 270.2., 327.6., 338.3	2.80., 3.60., 3.20., 11.40.,
		., 409.5	2.13
Ra-226	1600 years	186.2	3.28
Pb-214	1600,01 years	242.0., 295.2., 351.9.,	7.49., 19.20., 37.20.,
		768.4., 785.9., 934.1., 11155,2	5.04., 1.10., 3.21., 1.69

Table 2. The composition of association elements within 50 samples

Elements	Half life	Energies range (keV)	Deposit residues range (%)
Am-241	2.277 x 10^8 minutes	59.5	36.30
Cs-134	2.062 years	801.9	8.73
Cs-136	13.16 days	66.9., 86.3., 273.6., 340.6	12.50., 6.30., 12.66., 48.50
Cs-138	32,2 minutes	138.1., 409.0., 1147.2.,	1.40., 4.66., 1.24.,
		1343.6., 1435.9	1.14., 76.30
Ce-141	32,5 days	145.4	48.40
Ce-144	284.3 days	80.1	1.60
Ba-133	10.5 years	81.0., 276.4., 356.0., 383.9	33.00., 6.90., 60.00., 8.70
Ba-140	12.789 days	162.6., 437.5., 537.3	6.70., 2.00., 25.00
Cd-109	464 days	88.0	3.72
Se-75	119.78 days	96.7., 136.0., 264.7., 279.5.,	3.41., 59.50., 59.80., 25.20.,
		303.9	1.32
Te-132	78.2 hours	111.8., 116.3., 228.2	1.85., 1.94., 88.00
Co-57	270.9 days	122.1	85.51
Mo-99	66.02 hours	140.5., 181.1	88.70., 6.20

Fe-59	44.63 days	142.6., 192.3., 1291.6	1.03., 3.11., 43.20
Kr-85	3915.4 days	514.0	0.43
Kr-88	2.84 hours	166.0., 196.3., 362.2.,	3.10., 26.00., 2.25.,
		1179.5	1.00
Kr-89	3.16 minutes	197.5., 345.0., 369.3., 416.4	1.82., 1.18., 1.38., 2.56.,
		., 585.8., 696.2	1.78., 16.60
Sb-122	2.7 days	563.9., 692.8	70.60., 3.70
Sb-124	60.2 days	968.2	1.92
Sb-125	2,77 years	176.3., 380.4., 427.9., 463.4	6.89., 1.50., 29.33., 10.50
Xe-125	16.8 hours	188.4., 243.4	55.10., 28.20
Xe-131m	11.84 days	163.9	1.96
Xe-133m	2.19 days	233.2	10.30
Xe-135	9.11 hours	249.8	89.90
Xe-135m	15.36 minutes	526.6	81.00
Xe-138	14.13 minutes	153.8., 258.3., 396.4., 434.7	5.95., 31.50., 6.30., 20.30
I-124	4.18 days	1509.5	2.91
I-125	12.93 days	388.6	29.10
I-130	12.36 hours	536.1	99.00
I-131	8.04 days	284.3., 364.5	6.05., 81.20
I-132	2.295 hours	522.7., 630.2., 667.7	16.10., 13.170., 98.70
I-134	52.6 minutes	405.5., 847.0	7.30., 95.41
I-135	6.61 hours	220.5., 288.5	1.75., 3.09
Br-82	2118 minutes	221.4	2.26
Y-91m	49.71 minutes	557.6	95.08
Y-92	3.54 hours	448.5., 561.1	2.30., 2.40
Y-93	606 minutes	266.9	6.90
Y-94	18.7 minutes	381.6., 550.9., 618.4	2.20., 4.93., 6.70
W-187	23.83 minutes	134.2., 479.5., 685.8	9.50., 23.40., 29.20
Sr-91	9.5 hours	620.1., 652.3	1.72., 2.89
Sr-92	2.71 years	430.6	3.30
Sr-93	7.3 minutes	168.7., 260.1., 710.4	18.20., 7.30., 21.50
Zr-97	16.9 hours	254.1., 507.6	1.25., 5.30
Rb-89	15.44 minutes	272.5	1.42
Rh-105	2121.6 minutes	306.1., 318.9	5.13., 19.20
Ni-65	2.52 hours	366.3	4.61
Sn-133	115.1 days	391.7	64.90
Be-7	7.695×10^4 minutes	477.6	10.42
Nb-94	20300 years	702.6	90.00
Nb-96	23.35 hours	568.9	55.70
Nb-97	72.1 minutes	657.9	98.09
Ag-110m	3.598×10^5 minutes	446.8., 706.7., 818.0	3.64., 16.68., 7.30
As-76	1579.2 minutes	559.1	44.70
Cr-51	27.704 days	320.1	9.83
Eu-152	13.6 years	344.3., 444.0	26.50., 3.11
Te-96	21.28 days	1126.8	15.20

It is appropriate with the opinion from any geologists that the rock composition in the West Timor is formed from the complex rocks in several blocks. That is formed by collision between Australian continental shelf and Banda Arc which cause the appointment upward of the rock layer and also formation and deformation of rock in the form of break thrusts [12].

The content of radioisotope within the sample of mineral at Amarasi, Kupang West Timor Island, in general is composed in Actinium series (U-235) 50%, Uranium (U-238) 25%, and Thorium (Th) 25% and the others are association elements with counts, radiation energy, content percentage, and half life respectively range between 1 cps up to 24867 cps, 26.6 keV (Th-231) up to 1562.3 keV (Ag-110m), 0.19% (Th-232) up to 99.00% (I-130), and 3.16 minutes (Kr-89) up to 1.405 x 10^{10} years (Bi-211, Th-232, Pb-211, and Ac-228).

The composition of radioisotope are dominated by the elements concluded in the Actinium series (U-235, Uranium (U-235), and Thorium (Th): Th-231, Pa-231, Th-227, Bi-211, and Rn-219), Bi-212, Th-232, Pb-212, Pa-234, Ac-228, Ra-226, and Pb-214, and also *association elements consist of Am-241, Cs-134, Cs-136, Cs-138, Ce-141, Ce-144, Ba-133, Ba-140, Cd-109, Se-75, Te-132, Co-57, Mo-99, Kr-85, Kr-88, Kr-89, Sb-122, Sb-124, Sb-125, Xe-125, Xe-135, Xe-138, I-124, I-125, I-130, I-131, I-132, I-134, I135, Br-82, Y-92, Y-93, Y-94, W-187, Sr-91, Sr-92, Sr-93, Rb-89, Rh-105, Sn-133, Nb-94, Nb-96, Nb-97, Cr-51, Eu-152, and Tc-96. The other elements are detected by neutron activation analysis consist of: Fe-59, Xe-133m, Xe-135m, Y-91m, Zr-97, Ni-65, Be-7, Ag-110m, As-76, Cr-52, Au-198, and Ca-21*.

Radioisotope are included in Actinium series have radiation energy, counts, content percentage, and half life respectively ranged between 26.6 keV up to 426.9 keV, 1 cps up to 24867 cps, 1.0% up to 18.7 %, and 7.038 x 10^{8} years. Five examples of element composition spectrum in the samples of mineral are shown on Figure 3, 4, 5, 6, and Figure 7.

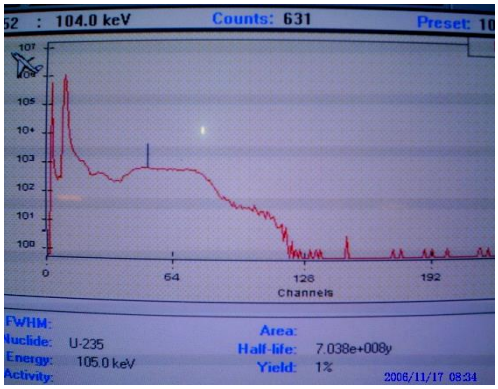

Figure 3. Radiation spectrum on sample 5b (Spl.5b.CNF)

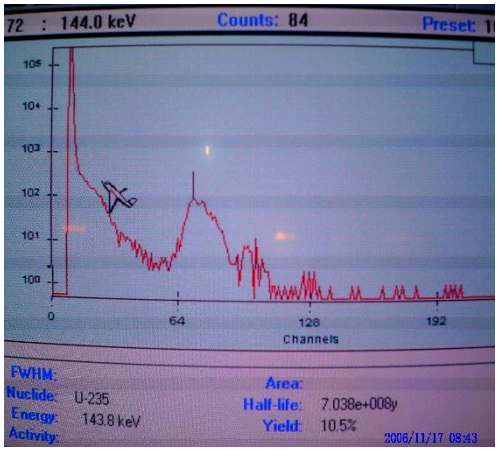

Figure 4. Radiation spectrum on sample 7b (Spl.7b.CNF)

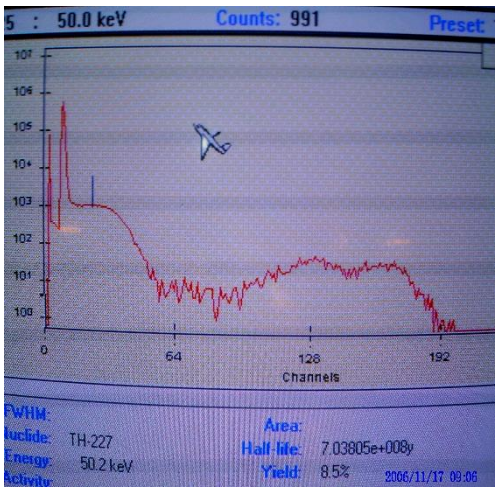

Figure 5. Radiation spectrum on sample 8e (Spl.8e.CNF)

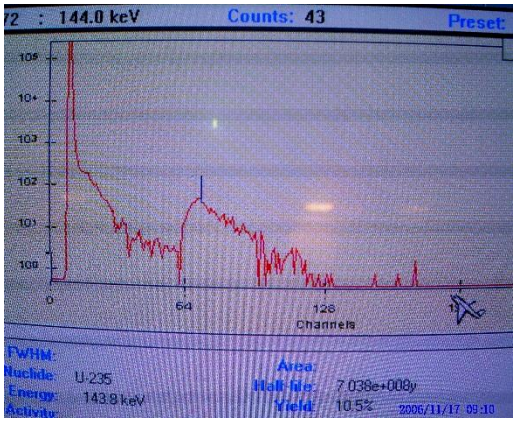

Figure 6. Radiation spectrum on sample 9e (Spl.9e.CNF)

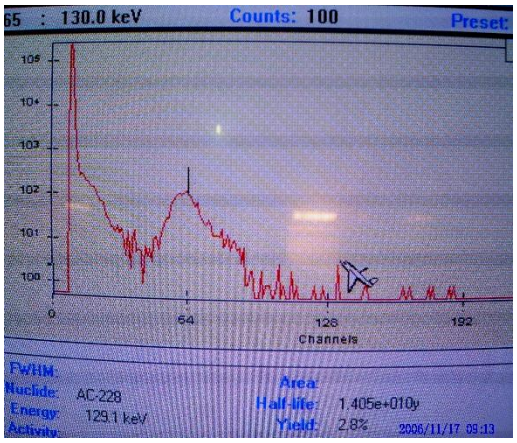

Figure 7. Radiation spectrum on sample 10d (Spl.10d.CNF)

Figure 8. Shows gamma spectrometry with Multichannel analyzer system and genie 2000 program, Figure. 9 shows research reactor (Hoger Onderwijs Reactor) in Interfaculty Institute Delft University of Technology the Netherlands, and Figure 10. show control room in Hoger Onderwijs Reactor (HOR).

Figure 8. Gamma spectrometry with Multi-channel analyzer system

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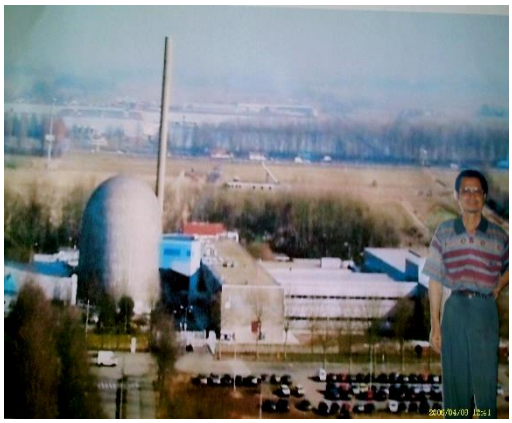

Figure 9. Hoger Onderwijs Reactor

a

b

Figure 10. a, b Control room in Hoger Onderwijs Reactor (HOR)

CONCLUSION

Based on previous analysis, can be proposed several conclusions:

1. The composition of radioisotope content within the sample of mineral at Amarasi, middle Kupang, and east Kupang west Timor island, a large part is concluded in

Actinium series (U-235) 50%, Uranium (U-238) 25%, and Thorium (Th) 25%.

2. The main elements of U-235, U-238, and Th-232 series components within the samples of mineral consist of: U-235, Th-231, Pa-231, Th-227, Bi-211, and Rn-219, Bi-212, Th-232, Pb-212, Pa-234, Ac-228, Ra-226, and Pb-214, also association elements consist of Am-241, Cs-134, Cs-136, Cs-138, Ce-141, Ce-144, Ba-133, Ba-140, Cd-109, Se-75, Te-132, Co-57, Mo-99, Kr-85, Kr-88, Kr-89, Sb-122, Sb-124, Sb-125, Xe-125, Xe-135, Xe-138, I-124, I-125, I-130, I-131, I-132, I-134, I135, Br-82, Y-92, Y-93, Y-94, W-187, Sr-91, Sr-92, Sr-93, Rb-89, Rh-105, Sn-133, Nb-94, Nb-96, Nb-97, Cr-51, Eu-152, and Tc-96. The other elements are detected by neutron activation analysis consist of: Fe-59, Xe-133m, Xe-135m, Y-91m, Zr-97, Ni-65, Be-7, Ag-110m, As-76, Cr-52, Au-198, and Ca-21.

3. The quantity of radiation energy, counts half life, and content percentage of radioisotope within the samples of mineral respectively ranged between 26.6 keV up to 1562.3 keV,1 cps up to 24867cps, 3.16 minutes up to 1.405 x 10^{10} years, and 0.19% up to 99.00%. For elements which are concluded in Actinium series (U-235), Uranium (U-128), and Thorium (Th-232) have the radiation energies, counts, half life, and content percentage respectively ranged between 26.6 keV up to 426.9 keV, 1 cps up to 24867 cps, 7.038 x 10^{8} years up to 1.405 x 10^{10} years, and 1.0% up to 18.7 %.

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