DETERMINATION OF THE CORAL AGE IN SPERMONDE ARCHIPELAGO MEASUREMENT ^{14}C ACTIVITY USING LSC (*Liquid Scintillation Counting*) METHOD

Jauhari, *Maming

Chemical Radiation Laboratory of the Department Chemistry Faculty Mathematics and Natural Sciences, Hasanuddin University

ABSTRACT

Research of Application of Liquid Scintillation Counter Method on Carbon Dating in Determination of Coral Ages from Spermonde Archiphelago have been done. Coral Samples were analyzed the coral surface from Lanjukang island are relatively low disturbing by human activities. The samples were cleaning according to physical and chemical treatmen using or mixture of acid-base solution: NaOH , H_2O_2 , $HClO_4$ and HCl. The step remove about 9% mass of the sample and it leaves white. Carbonat of sample were remove as CO_2 by reaction with H_3PO_4 85% and it was trapped by 1 N KOH as K_2CO_3. Total carbon in the sample can be determined by titration method with the total weight of carbon sample are 1,315-1,353 g / 8 mL. Specific activity of carbon-14 in the sample that were counted by Hidex 300 SL liquid Scintillation Counter are 14,11 ± 0,5- 15,3 ± 0,6 DPM/gC related to their age. Their age which have estmated by application the data specific activity of the samples and specific activity karbon-14 in the modern carbon (15.3 ± 0.1 DPM/gC) to radioisotop desintegration equation are the moderen carbon age - 669, 484 ± 20 years.

Keywords : *Carbon Dating, Liquid Scintillation Counting, Coral, Spermonde Archiphelago.*

INTRODUCTION

Indonesia has one of the distribution centers for the coral reefs throughout the Indo - Pacific, the coral reef area over 60,000 km^2 of which is widespread in some areas of the islands. Most of the coral reefs in the area of Sulawesi, Bali, Lombok, Papua, Java, Riau Islands and the west coast and the southwestern tip of Sumatra Island (Darlan, 2012).

Coral reef ecosystems are one of the oldest ecosystems on earth still ditembukan , which have ups and downs since the continuous

development of more than 5000 years ago Tamrin (2007). These species have a life time or a very long lifespan, with some suspicion supported by geologists such as Shepard (1971), Kuenen (1960), Bird (1976) , Mater and Bennett (1984) , who agrees to say that 75 % of all reefs reefs formed during the Pleistocene (Rositasari , 1996). And no exception coral reefs are in Spermonde islands located in the southern part of the strait of Makassar who have high levels of coral diversity is quite high because there are 78 genera and sub- genera , with a total of 262 species, as has been noted by Moll (1983) spread in coral island from north to south parallel to the mainland coast of the island of Sulawesi (V. Vauren in Klerk, 1983) . Jompa (1996) noted the presence of live coral cover and diversity of coral species that occur in the region of about 20 % within 15 years. Dynamics of changes pada ekosistem reefs can diketaui through the process of determining the age of the radiocarbon dating method . The dating is based on the presence of carbon isotopes (carbon-14) contained in living organisms obtained through the process of photosynthesis as well as a series of processes that food does. Carbon-14 will decay when the organisms die with a half-life of 5730 years Faure (1986).

Carbon-14 has a very low specific activity although the sample is still fresh. Therefore, for the purposes of census enumeration required special tool with a low radiation counter (LBC, Low Background Counter). Counter instruments that meet the radiation measurement standards are liquid scintillation counter or LSC (Liquid Scintillation Counting), the measurement geometry which can reach about 99,99 % counting efficiency. It is caused by a liquid scintillation counter equipped with radiation detectors and concentrated on radioactive samples to be measured dissolved into liquid scintillator to emit multiple photons. So get a high accuracy in interpreting the data results of counts (Tjahaja and Mutia, 2000).

Application of the method LSC (Liquid Scintillation Counting) by measuring the activity of carbon- 14 in determining the age of a lot of the material has played an important role, not only in the discovery of the age of ancient objects in the world arhkeologi, but also thrive in the determination of the age of the sediments , corals , shells , water , soil and other Siregar (2008) . Such study ever conducted in the Laboratory of Hydrology and Radiation Isotope Application Center (PAIR) - BATAN now called P3TIR - BATAN applying LSC method in analyzing samples

from marine coral beach in the area Srandil in Sri Lanka and Indonesia. From the measurement results , it is known that the age of the reefs varies from Sri Lanka (3495 ± 68) years up to (8515 ± 43) years. While the age of the reefs in Indonesia are (1840 ± 63) years. Generally beaches in Indonesia does not have this data (Yuliati and Akhadi, 2005).

This study will apply the method LSC (*Liquid Scintillation Counting*) in the determination of the age of deep-sea coral Spermonde Islands based on the measurement of the activity of carbon-14 contained in the sample.

METHODS
Time and Location

The experiment was conducted from August to November 2013 in the Chemical Laboratory of Radiation Chemistry Department, Faculty of Mathematics and Natural Sciences, Hasanuddin University.

Tools and materials

Diving equipment (SCUBA DIVING) , LSC Hidex 300 SL, Coral Reef Origin Kepuluan Lanjukang, Spermonde Island .

Method

Sampling dilakukan Lanjukang Island Spermonde Islands with capture location at coordinates S : 119 ⁰ 04 ' 27,545 " E : 04 ⁰ 55 ' 11,856' by 4-5 meters from the surface into the sea,

coral reefs sampling by SCUBA divers assisted with tools such as drill and hammer.

Cleaning Samples

As the early stages of coral reef samples after cleaning with the physical and chemical leaching. Where the physical washing samples were washed with running water while brushed and rinsed with distilled water several times, then to remove the surface carbon source , organic stains and some soluble matrix that accumulates in reef samples for the water can be removed by immersing the samples in a mixture (50/50) 30 % H_2O_2 and NaOH 1 N while diultrasonik for ± 10 minutes. After the samples were washed and rinsed, the samples were stored back in the mix (50/50) 30 % H_2O_2 and $HClO_4$ 1 N for ± 30 seconds and the last in the chemical leaching process is the sample immersed in 6 N HCl , rinsed with distilled water.

Separation of Carbonate Samples

Carbonate reefs separated as CO_2 by adding H_3PO_4 85 % in the 10 g sample and to form gas bubbles and carbonate samples completely reacted with H_3PO_4 85 % (Figure 1). The resulting gas bubbles in the ocean absorbing passed 1 M KOH resulting reaction K_2CO_3 dissolved as follows :

$$CaCO_3 + H_3PO_4 \longrightarrow CaHPO_4 + CO_2 + H_2O$$
$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$
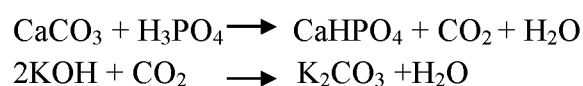
Furthermore, the sample is calculated from the total carbon concentrations of carbonate obtained by titration with HCl 5 M. Measurement of the activity of 14C in the sample solution used liquid scintillation counter Hidex 300 SL with methyl orange indicator for the determination of total alkali and phenolphthalein indicator dab in the determination of alkaline OH after carbonate precipitated with 10% $BaCl_2$.
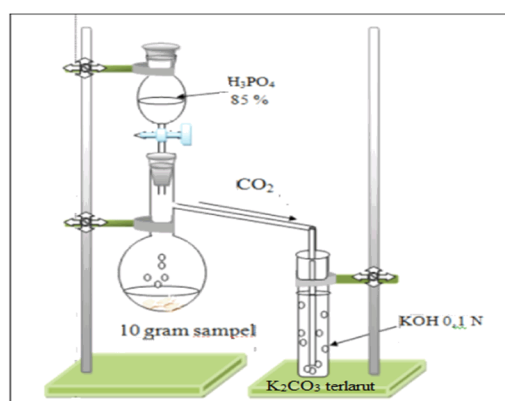

Figure 1. Design tools as CO_2 separation carbonate reef sample.

Sample enumeration

Sample enumeration is done by filling in 8 mL of sample solution (K_2CO_3 dissolved) and 12 mL of scintillator into a 20 mL vial. Homogeneous mixture of sample and enumerated by the LSC sentilator Hidex 300 SL with a time of enumeration 1-1440 minutes. Enumeration generate data in units of counts CPM (*Counts Per Minute*), TDCR (*Triple To Double Coincidance Ratio*) and DPM (*Decays Per Minute*)

for the results obtained from the CPM with TDCR samples.

Determination of Age

Age samples of coral reefs can be calculated based on the ratio of the specific activity of modern carbon (15.3 ± 0.1 bpm / GRC) to a specific activity of samples obtained from the enumeration by using radiocarbon decay rate equation:

$$t = \frac{t_{1/2}}{ln\,2}\,ln\,\frac{A_0}{A}$$

A   = Radioactivity of ^{14}C isotopes in the sample

Ao = Radioactivity isotope ^{14}C during the life of plants or animals (15.3 ± 0.1) DPM (Libby. 1960)

$t_{1/2}$ = Half-life ^{14}C = 5730 ± 40 years

Ln2= 0.693

RESULTS AND DISCUSSION

Sampling of coral reefs Election Lanjukan island as a place of coral reefs due to sampling Lanjukan Island is one of the outer islands within 40 km from the city of Makassar. Supported also by the condition of belonging to a deserted island and relatively far from human activity so that the condition of coral reefs around the island is generally still very good. There are two coral samples taken at the study site. Both samples of coral reefs are in the same species of the genus *Acropora*.
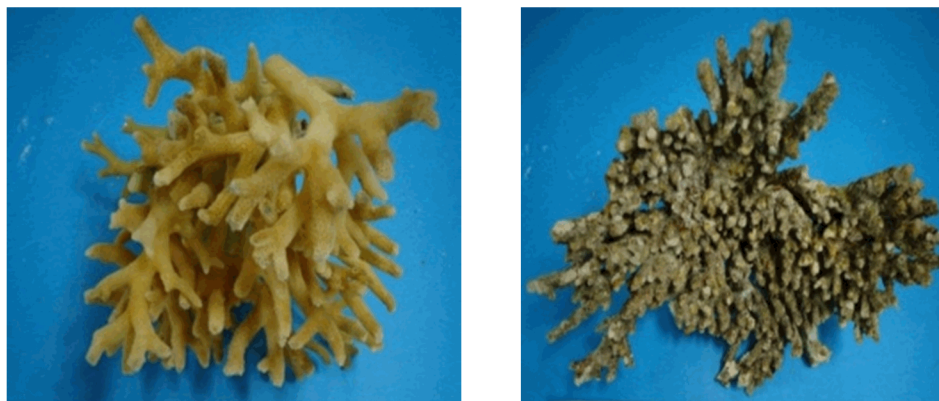
Figure 2. Coral Reef Sample I and Sample II Origin Lanjukang Island Spermonde Islands.

Sample results Laundering Coral Reef

A series of stages in the process of washing the sample either physical or chemical leaching leaching able to eliminate any contamination found in samples of natural coral reefs. Serangakaian through the washing process is capable of producing reefs appear white with the loss of a source of carbon impurities and the sample surface as much as 9 % .

Where is the missing part of the sample is a natural contamination accumulated over the waters and the coral reef matrix surface is dissolved.

Results Determination of Total Carbon in 8 mL of sample solution

Determination of total carbon can be achieved by titration using HCl 5 M. Diproleh the total carbon in the sample I is 1,353 g / mL and 1,315 8 g /8 mL in sample II. Total carbon was obtained from each of 8 mL of sample solution used in calculating the specific activity of carbon - 14 is expressed in units of disintegrations per minute per unit mass of carbon (DPM /gC), which became the basis for the calculation of the age of the sample.

Enumeration Sample

Activity of carbon - 14 and TDCR values obtained from the counter mix 8 mL of sample and 12 mL of scintillator in a 20 mL vial with a liquid scintillation counter Hidex 300 SL in rentang the time pencacahan 1-1440 minutes as shown in Figure 2. Where there are differences between the enumeration results of counts 1-30 minutes with pencacahan 60-1440 minutes. The increase of counts in the first minute until the enumeration 30 minutes due to the instability of the solution phase both in physical and chemical

conditions. Effects and the influence inception in the early pencacahan cause efficiency chopped very low at around 20 % which can be seen from the values in the range of 0,2 to TDCR enumeration 1-30 minutes. Cause the emulsion formed berkurangya transparency properties of the scintillator solution so that the photons that enter the MPT very little and cause reduced effisensi enumeration. In contrast to the results of counts obtained at the time of enumeration 60-1440 minutes .

of Chemiluminescence and emulsion At the time range of counts obtained count values are relatively stable ranging between 62-68 CPM, with approximately 60% efficiency chopped , or TDCR value in the range of 0,6. This situation is similar to both the time of enumeration sample I and sample coral reefs II until the enumeration to 1440 minutes. The stability of the results of counts sampled at 60-1440 minutes due to physical and chemical conditions that seem stable solution.
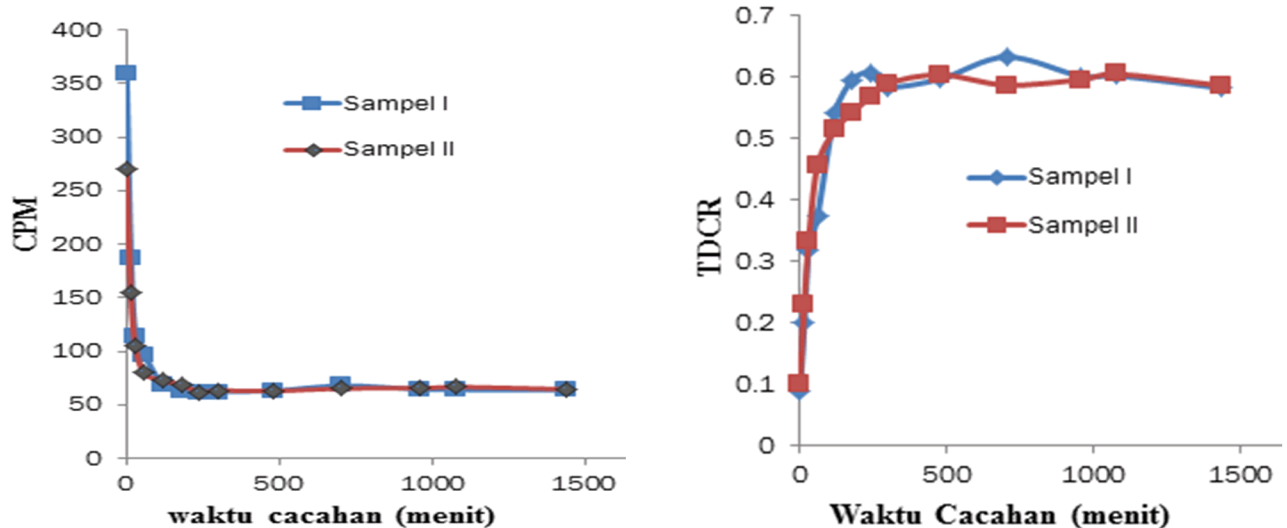

Figure 3. Activities and TDCR sample solution reef sample I and sample II katrang reefs in the span of counts 1-1440 minutes.

Determination of Specific Activity Sample of Coral Reef.

The specific activity of the sample will be the basis for the calculation of age. Where specific activity obtained from the value of decay per minute (DPM) divided by

the total carbon content in 8 mL of sample was mixed with 12 mL of scintillator. The average specific activity (AS) samples from the calculation of disintegrations per minute (DPM) per unit carbon future

samples can be seen in the following   table 1

Table 1. Specific Activity Data Average 14C Samples Coral Island Lanjukang
      Kepulauan Spermonde

Terumbu karang	DPM	C-total (gr)	As (DPM/gr C)
Coral I	20,8	1,353	$15,3 \pm 0,6$
Coral II	18,6	1,315	$14,11 \pm 0,5$

Value of the specific activity of the coral reef sample I shows the value of the specific activity of modern carbon (carbon - 14 activity in the time when the plant or animal life) which is 15.3 ± 0.1 dpm /gC (Libby , 1960; Yuliati , 2005). This is due to the coral reef sample I analyzed a fresh coral reefs so categorized in specific activity specific activity of modern carbon . Unlike the coral reef sample II, with a specific activity of carbon - 14 amounting to 14.11 ± 0.5 bpm / GRC , a little more lower than the value of the specific activity of modern carbon 15.3 ± 0.1 dpm / GRC , this indicates that there has been a decay of the nucleus of an atom of carbon - 14, which starts from the coral reefs die sample , so that the activity of carbon – 14 contained in the sample is reduced and smaller than modern carbon specific activity 15.3 ± 0.1 dpm/gC (Libby, 1960).

Sample calculations Age Reefs

Specific activity obtained differences can give an idea on the age of the analyzed samples of coral reefs. Age coral reefs calculated based on the comparison of the specific activity of modern carbon ($15.3 \pm 0,1$ bpm/ gC) to a specific activity of samples obtained by using equations decay rate is diproleh radiocarbon age from the island reefs Lanjukang Kepuluan Spermonde is aged 0-669, 484 ± 20 years. This indicates that the location of the study results in the death of coral reefs along with new growth .

CONCLUSION

Age origin of coral reef islands Spermonde Islands Lnjukang calculated based on data specific activity of carbon - 14 is berumbur 0 to 669.484 ± 20 years.

REFERENCES

[1]   Bird, E.C.F., 1976, *Coast; An Introduction to Systematic Geomorphology*, Australian National University Press: 219 - *243.*

[2]   Darlan, U., 2012, *Terumbu Karang, Potensi Besar Bagi Negara Bahari*, Buletin - Oseanografi, (http :// www. Buletin Oseanografi.com diakses pada tanggal 30 Januari 2013).

[3]   De Klerk, L.G. de., 1983. *Zeespigel Riffen en Kustflakten in Zuitwest Sulawesi, Indonesia*, PhD Thesis Utrecht Netherland.

[4]   Jompa, J., 1996, *Monitoring and Assessment of Coral Reefs On Spermonde Archipelago, South Sulawesi*, Thesis, MC Master, Canada.

[5]   Kuenen, H., dalam John Willey dan Sons, *1960, Marine Geology*, New York: *423 - 453.*

[6]   Libby, W.F., 1960, Radiocarbon Dating, *Nobel Lecture*, Elsevier Publishing Company, Amsterdam.

[7]   Mather, P., dan Benne'it (eds.), 1984, *A Coral Reef Handbook.* The Australian Coral Reef Society: 4- *12.*

[8]   Moll, H., 1983. *Zonation and Diversity of Scleractina On Reffs Off South Sulawesi Indonesia.* Thesis. Leiden University, Netherland.

[9]   Siregar, D.A., Satrio, 2008, Pola Dinamika Air Tanah di Daerah Bekasi Berdasarkan Analisis Radioisotop ^{14}C, *Pusat Survei Geologi dan Pusat Aplikasi Teknologi Isotop dan radiasi*, Batan, **19** (1) : 17-22.

[10] Rositasari, R., 1998, Aspek Ekologi dan Sejarah Pembentukan Terumbu Karang, *Balitbang Oseanografi, Puslitbang Oseanologi-LIPI*, Jakarta, 13 (**3 , 4**) : 1-9.

[11] Tjahaja, I.P., dan Mutiah, 2000, Metode Pencacahan Sintilasi Cair : Salah Satu Alternatif untuk Pengukuran α dan β Total dalam Sampel Lingkungan, *Indonesian Journal of Nuclear Science and Technology*, **1** (1) : 31-46.

[12] Yuliati, H., Akhadi, M., 2005, Radionuklida Kosmogenik Untuk Penaggalan, *Puslitbang Keselamatan Radiasi dan Biomedika Nuklir*, Pusat radiasi Batam.