A survey of different techniques to analyze the coral for the analysis of sea-surface property variation and effect of climate change

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ABSTRACT

Global warming is continuous process and it results into the climate change and overall temperature increase of the earth. Human activities highly impacts on the rate of this overall temperature change. This temperature change affects all living and non-living things of the earth. Effect of Climate change is critical for eco-system on earth. In eco-system due to climate change, many species become successful in order to sustain their life but many not. So, the study of the climate change is necessary for the future of the earth. Study of climate change can be done by doing scientific study of climate change tracers. One of the climate change tracers is coral reef. By scientifically analyzing the coral sample, the changes of sea-surface property variations can be studied and tracked down.

An instrument is required for the scientific study of the coral sample. Over a period of time, many instruments are invented for the same purpose. Technology change also impacts on the working principal of instruments. This paper includes the study of different instruments to summarize the advantages and disadvantages. So, it can helpful to propose an instrument to analyze the coral reef sample to study sea-surface property variation thus climate change.

Keywords: - *Coral reef scanner ,study of sea surface property variation, Climate change study*

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1. INTRODUCTION

1.1 INTRODUCTION TO CORALS

Corals are tiny, lithe and delicate creature found in warm and shallow oceanic water. To sustain their lifer, these creature forms colonial structures made of Calcium Carbonate. Generation to generation of corals, these structures are results into the Reef. t.e. Known as “Coral Reef.” Coral reefs often known as "rainforests of the sea" and are the part of diverse underwater eco-system.

1.2 CORAL REEF AND CLIMATE CHANGE

Coral grows under water in terms of calcium carbonate and it forms skeleton structure. The density of these calcium carbonate depends on many things like water temperature, availability of light, and nutrient conditions change, sediment flow seasonal and decadal information’s. Corals are extremely sensitive by changes in climate conditions. As example, the density growth is different in summer and in winter. These variations in produce growth rings on it with different bands and density. The Corals can be easily affected by global warming cause by pollution and river run-off. It causes many problems and it is possible to track it by analysis of these reef samples.

In most cases, the optimum temperature range for most coral reefs is 26–27 °C. slight temperature increases in ocean more than these range can harm corals. Climate change causes overall temperature rise in oceanic water. Already climate change increased the oceans’ temperature and it have affected badly on the health of corals and bleached it in many areas as it results into pH variation of seawater. Most of species are succeeded but not all to sustain its existence under climate change which some modifications in it. So, it's necessary the observation of these reef to understand the climate change.

1.3 CORAL REEF SAMPLE ANALYSIS

The study coral ring bands and other characteristics of coral samples are the focus for scientific analysis. These growth bands tell an exact year and season effect; thus the climate change effects can be determined.

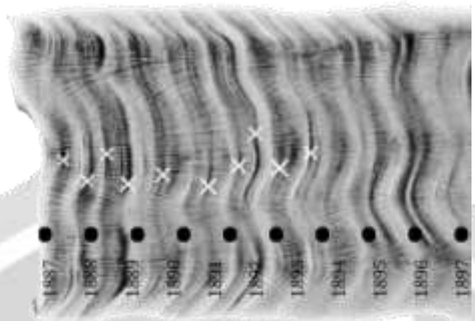

Fig -1: Coral Reef Sample and its interpretation by Scientists

Mostly, the band patterns from the sample can be viewable by naked eye. The above figure-1 shows such band pointed marked by 'x' and also contains time-line marking details. After defining sample's geo-locations related details and dependent parameters, the scientific analysis of sample becomes easy.

For inspection of sample, Instrument having technology like X-ray machine, UV source scanner or may be different requires. It depends on scientific problem. It's not possible to take any sample directly and analyze it. These samples require further chemical preprocessing and cleaning.

2. LITERATURE REVIEWS

Many instruments offer to scan the coral sample for the scientific analysis purpose. As instruments are technology dependent, it offers different features. So, such highly precise instrument is required that can facilitate the coral sample's scanning that having maximum features without distortion of sample details. Here, the impact of climate change and reviews of such instruments are provided.

2.1 CLIMATE CHANGE, HUMAN IMPACTS, AND THE RESILIENCE OF CORAL REEFS

Climate change, seasonal effects and temperature variation affects the coral reef. Effect of Climate change is critical for eco-system on earth. A zone from 30° N to 30° S of the equator, Coral species can be easily available. Corals commonly found at shallow and warm water, but there are few species that found under deep water and cold water but at smaller scales in other areas.

Due to climate change Coral reefs are dying and some of them shows greater tolerance and make some changes within itself to sustain life. Most of corals species are disappeared under marine water. It results into the effect of bleaching, dying and changes the coral density. But it can't conserve themselves by the effect of bleaching, lesser density and many issues. As human haven't full control on the climate change but its effects can be decreased. Global fishing trade route must be defined to conserve marine species system [1]. the human interference can be reducing. This paper also describes effect of climate change, sea temperature effect, Global Trade route effect, longitude and longitude locations of the Coral reefs and species deadline to disappear from the earth. From this information it is possible to make global strategy to understand climate change and to conserve these species.

2.2 MEASURING THE SPECTRAL SIGNATURES OF CORAL REEFS

The effect of Environmental CO_2, Sun Light, calcification rate of coral growth results into different growth of the coral species and thus change in spectral signature [2]. An instrument named 'Spectroradiometer' used to separate corals and non-corals from each other via measuring spectral reflection from sample and by measuring the spectral reflection and absorptions [2]. The entire process is divided into two part: sensor unit, control unit. Broader study was carried out by studying different 16 types of coral species [2]. For the analysis, First Coral reef areas would be identified with the use of sensor unit measured by aircraft or satellite to separate underwater object from coral reef sample and then '*spectroradiometer'* is used to measure spectral signatures at ground level in developed artificial lab [2].

Spectroradiometer consists a lab in form of water tank under illumination of 500W Tungsten lamp. Now, reflection of light is measured in terms of wavelength. These reflection varies from species to species and its recorder for the analysis. Another aim of this experiment is to differentiate corals from other marine obstacles. It differentiated by reflected light capture under specific wavelength. Results are measured and categorized as reflection of light by upwell, down well and specific range t.e. 660 to 680 nm spectral region [2]. The difference between corals and non-corals is measured and that is between 700 to 800nm [2]. This experiment shows very narrow absorption at around 660. They found very strong reflection at 700nm to longer wavelength in spectral region [2]. Non reef rocks are differentiated via wavelength range reflection and found that non reef rocks and sand neither absorb too much nor reflect strong wavelength [2]. The same experiment is repeated on 16 species of coral reefs [2].

Another main conclusion is that, measured sensors data's variability depends on a part of wavelength absorbed by the marine water, environmental effect when data is captured, availability of sun light in water and spectral resolution of sensors [2]. These are must be counted for analysis of the data. Homogeneous condition is required for high precision [2].

2.3 MEASUREMENT OF LUMINESCENCE IN CORAL SKELETONS

Luminescence bands of coral reef are measured with ultraviolet light based instrument [3]. For the scanning, coral samples are cut down in form of thin slab. The thickness of coral slices should be decided carefully. These slabs are previously cleaned and further processed. Now, for observation, samples are laid on table that movies with 0.25mm steps in one direction for continuous measurement under ultra-violet light (UV). For the movement of the sample in this case they used stepper motor that moves 0.254mm per seconds [3]. In past experiments, problems were faced regarding to the fluctuation of light source. Tungsten Halogen Lamp 250W as a light source is used. It is observed that AC light source introduce variation in light intensity as supply voltage is fluctuated [3]. As a remedy, regulated DC source have used instead of 25 AC source [3]. Here, for a measurement arrangement is made a such that light passes from source to filter then fiber cable to the sample. Now, reflected light from sample is also collected via fiber cable and feed to the photomultiplier tube (PMT) via filter.

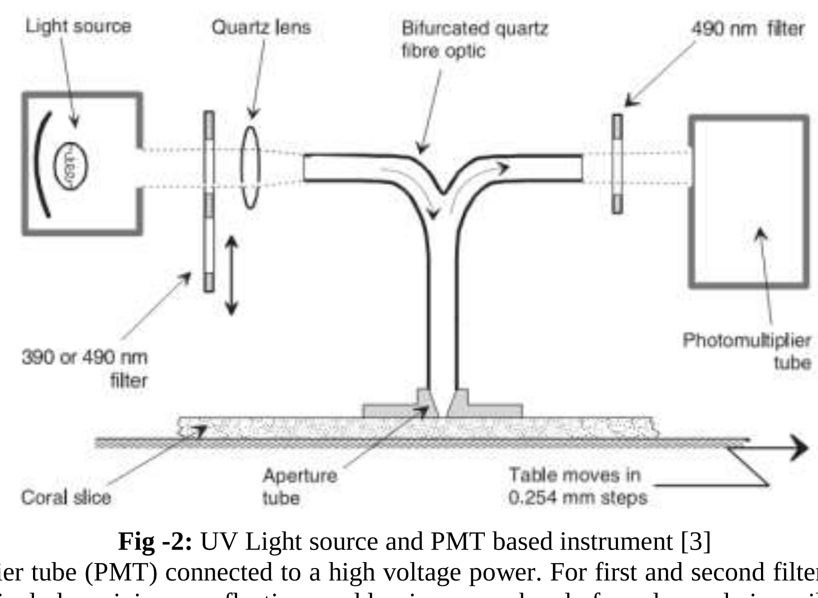

Fig -2: UV Light source and PMT based instrument [3]

Here, photomultiplier tube (PMT) connected to a high voltage power. For first and second filter light wavelength is such chosen that it includes minimum reflections and luminescence band of coral sample is easily identifiable. Here, wavelength of 390 nm is used for the filter and photomultiplier tube (PMT) connected to a high voltage power [3]. The choice of wavelengths is depending upon coral sample. PC controls entire measurements.

For the output graph analysis, Better knowledge is required to relate seawater dilution and luminescence. One important conclusion is that this x-ray measurement technology is slightly older and its output is somewhat distorted and not as much accurate in order to understand Humic Acid pigment analysis.

2.4 ACOUSTO-OPTIC TUNABLE FILTER BASED INSTRUMENT

Acousto-Optic Tunable Filters is used to measure luminescence bands of corals in this instrument. There are many problems regarding absorption and reflection frequency, it can be faced during scientific observations. If fixed frequency is used for different coral species and light range, then output result may become unreadable. To overcome this problem, quartz-collinear acousto-optic tunable filters (AOTFs) were used for the tuning purpose [4].

In instrument synchronization between absorption and reflection of light is achieved by liner polarized crystal and acoustic absorber. In experiment setup HeCd used as a light source. From light source it passes from filter then interference filter to PMT via polarizer and quartz cell limiting polarizer filter. To control all these things 16-bit microcontroller board is used. Polarized monochromatic light was obtained by liner polarized crystal that reduces excess low-frequency noise. Using polarizer, Max 80% polarized light can be achieved. Acoustic absorber is used to absorb unwanted noise and variations. One thing is observed here is that working and tuning frequency is based on Tellurium Oxide (TeO_2) Crystal (for near infrared and visible range). It may change according to the experiments. Below 350 nm result is unobtainable and system's effective rejection is decreased below 635nm wavelength [4]. The another advantages of this instrument is that it doesn't required a separate shutter for phosphorescence measurements.

The mentioned instrument is portable mechanical simple luminescence spectrometer that used quartz-collinear acousto-optic tunable filters (AOTFs) and Acoustic absorber to provide synchronization between excitation and emission wavelength [4]. The working and tuning frequency is near infrared and visible light range generated HeCd light source. This instrument is in small size and offer fast scanning in terms of milliseconds to few seconds.

2.5 EFFECT OF EXCITATION WAVELENGTH ON MEASUREMENT

It results into unwanted emission wave and decreases the accuracy of plotted graph. Based on different coral spectral signature, reflection and absorption of spectra is changing from sample to sample. An instrument with fluorescence-eliminating filters having five filters in form of wheel having different wavelength. This Five-step filter wheel is used to select different excitation condition manually under 50-W halogen bulb as a light source [5]. In experiment, author focus on the fluorescence from pigments under the 400–650-nm wavelength range and found that between 450 to 550 nm range, sharp peak is eliminated [5]. The fig-3 shows the Excitation and its undesired emission of wave.

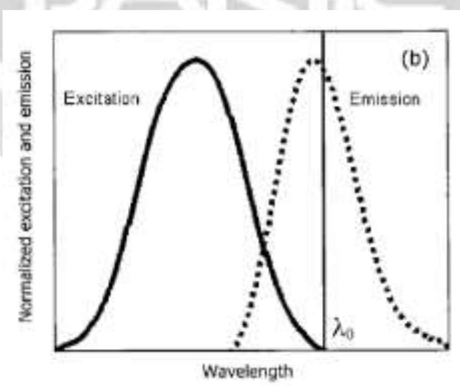

Fig -3: Normalized Excitation and emission vs wavelength Graph

2.6 DECADAL OSCILLATION EFFECT

Apart from seasonal effects there is impact of cyclic effects as earth is moving in parabolic manner around the sun. In that, ocean-atmosphere varies on decadal time scales. Pacific Ocean and El Nin ˜o-Southern Oscillation (ENSO) are example of this Decadal Oscillation effect [6]. The seasonal, decadal and any other effects can be easily observable by analyzing the luminescence bands of coral skeletal. Unfortunately, the cyclic effect concept is poorly observed because of older measurement techniques.

Normally, if coral samples are analyzed under normal X-Ray Scanning based instrument then decadal effect will be not understandable and may shows inappropriate readings. With the use of digital X-rays machine, the age model based on density of coral bands can be easily constructed. The Ca/Ba concentration and Humic Acid pigments cannot be explained by older techniques [6]. To understand this Decadal Effect, Coral cores required some chemical and cleaning pre-processing. Then it should be measured with Spectral Luminescence Scanner. By analyzing with different color spectra and diving different spectra, the decal effects can be analyzed and understand climate change in better ways.

2.7 SPECTRAL LUMINESCENCE SCANNER

A new rapid "spectral luminescence scanning" (SLS) technique is developed and it became successful to overcome disadvantages of older techniques. In this technique, sample is observed under red, green and blue (RGB) spectrum for analysis. By using spectral ratios of color luminescence, analysis of the decadal effect can be achieved for analysis. This new machine helps to analyses decadal effects with most precision. Analysis of Humic Acid pigments in corals becomes easy in spectral luminescence scanning technique. It reduces the efforts to analyses coral carbonate skeletons with highest precision than previous. Spectral Luminescence Scanner gives more precise and accurate observations compared with older technology.

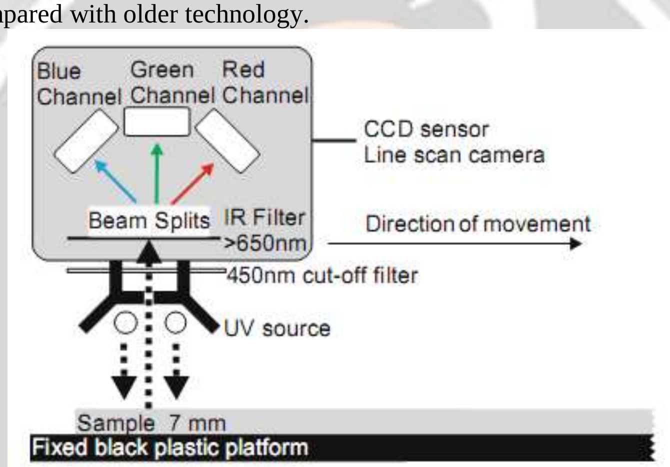

Fig -4: Scanning system diagram [7]

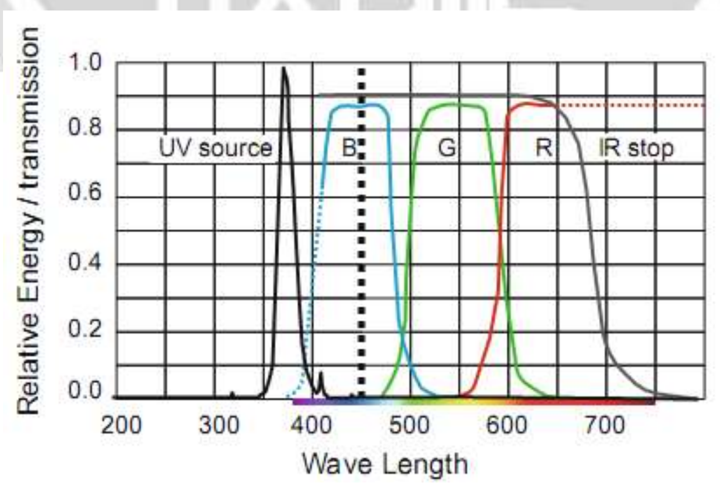

Fig -5: RGB Spectra output graph [7]

The main parameters are used in SLS are described here. This machine used the range of 315 to 450 nm as UV light source and 450nm as a cut-off frequency of filter to eliminate reflected light from beam splitter [7]. To eliminate the light of higher wavelengths from CCD sensor, a 650nm infrared cut-off filter is also used [7].

2.8 IMPROVEMENT IN SPECTRAL LUMINESCENCE SCANNER

SLS techniques is best for carbonate materials. G/B spectra ration is most useful to reconstruct the river-run off discharge. From different-different locations Coral samples were picked up and tested under SLS machine and reliable output is observed. To improve the result, instead of 450nm Filter, they have used “Schott GC 455nm long Pass Filter” [8]. To improve the sample’s luminescence bands one can treat it by NaOCl, soak it as per requirements [8]. One can use any other method to clean the sample. This filter and cleaning process improves the detection of luminescence bands.

3. SUMMARY

Older X-Ray based instruments haven’t capabilities to analyses the coral samples to detect decadal effects. For that, “Spectral Luminescence Scanning” Techniques is must require. By the ratio of two spectra (e.g. G/B) and individual RGB spectra, one can analyses sample in better way. It indicates the concentration of Ca/Ba and availability of Humic acid pigments. The ideal wavelength of light for sampling is 400 to 600nm should be used for spectral scanning. The synchronization between excitation and emission wavelength is must require that can be achieved by variable light filter. As a light source, DC source based power supply should be used instead of AC Power supply to avoid light intensity fluctuations. Light source should not have fluctuated in order to avoid the unnecessary variations in result and specific wavelength should be used. To scan each point of coral sample, XY-Motion platform is advantageous compared only X-Motion Platform. The obtained result is also depended on the depth of marine water, availability of light, seasons, availability of sediments and temperature of the water. The coral sample must be cleaned and preprocessed and cut down into slices for better visualization of clear luminescence bands. The cutting style of sample also affects the results. The location of reef also plays the important role to relate the result with the climate change.

4. CONCLUSIONS

The spectral Luminescence Scanning (SLS) technique is most advanced technique for the coral sample analysis. It is most helpful to understand seasonal as well as decadal effects happens in oceanic environment. Disadvantages of older techniques can be overcoming by SLS.

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