Past Sea Level Data

Middle School Grades

Lesson Summary

Students will graph past sea level data obtained from the dating of coral reefs off Papua New Guinea and discuss the implications of changing sea levels.

Prior Knowledge & Skills

- Graphing skills
- Know that sea level has not always been the same

AAAS Science Benchmarks

The Mathematical World

Numbers

Symbolic Relationships

Habits of Mind

Communication Skills

NSES Science Standards

Science as Inquiry

Abilities Necessary to Do Scientific Inquiry

Earth and Space Science

Structure of the Earth System

History and Nature of Science

Nature of Science

NCGE Geography Standards

The Uses of Geography

Standard 17

Teaching Time: 20 – 30 minutes

Materials

- Graph paper
- Ruler
- Pen or pencil

Advanced Planning

Preparation Time: ~10 minutes

1. Review the instructions
2. Gather the necessary supplies.

Recommended Reading: (attached)

- Hot Topics: Dating Corals, Knowing the Ocean

LASP
LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS

Lesson Plans: Past Sea Level Data

Objective

The objective of this activity is to feel the changes of sea level in the past.

Materials

Each student or group of students will need the following:

- Graph paper
- Ruler
- Pen and pencil

Important Points to Understand

- In the past the sea level has not always been the same.
- If climate changes caused by human activities do not exist, sea level changes by time is a kind of natural process.

Preparation

Try to explain that the information given in the following table, which lists the sea level for the last 250,000 years, as recorded by thorium/uranium dating of coral reefs off Papua New Guinea.

Thousand years before present	0	10	20	30	40	50	60	70	80
Meters below present sea level	0	23	119	54	44	72	55	71	22
Thousand years before present	90	100	110	120	130	140	150	160	170
Meters below present sea level	59	20	48	27	5	16	123	111	30
Thousand years before present	180	190	200	210	220	230	240	250	-
Meters below present sea level	57	87	46	32	7	25	12	32	-

Procedure

1. Plot a time versus sea level graph. Time is on horizontal axis starting from 250,000 years before present and meters below present sea level on the vertical axis down from the horizontal.
2. Remember the time step (10 thousands years) and study the sea level relative to present level.

Questions

1. How does the present-day sea level compare with that of the recent past?
2. What do you think of the present sea level? Is it alarming?

Office of Science
U.S. Department of Energy

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Thousands of Years Before Present			Meters Below Present Sea Level		
	0			0	
	10			23	
	20			119	
	30			54	
	40			44	
	50			72	
	60			55	
	70			71	
	80			22	
	90			59	
	100			20	
	110			48	
	120			27	
	130			5	
	140			16	
	150			123	
	160			111	
	170			30	
	180			57	
	190			87	
	200			46	
	210			32	
	220			7	
	230			25	
	240			12	
	250			32	

Hot Topics

Hydrothermal Vents

Godzilla, Sasquatch, and Homer Simpson: The Curious Names of Deep-sea Features

Bacteria at Hydrothermal Vents

Looking for Microbes

Biogeography of Hydrothermal Vents

Seafloor Geology

Seafloor Gravity

Seafloor Magnetics

Lava Flows

What Does a Young Submarine Lava Flow Look Like?

Hotspots & Cool Volcanoes: The New England Seamounts

Extreme Creatures

Deep Sea Biology

Galápagos Animal and Marine Life

Seabird Observations in the Western Galápagos Islands

Deep-Sea Corals

Hot Topics: Dating Corals, Knowing the Ocean

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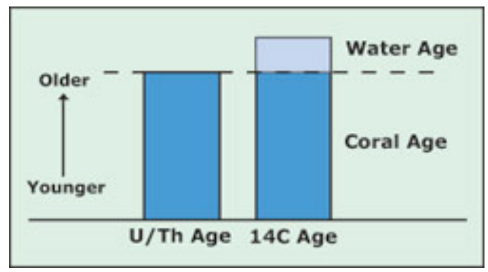
Locating corals in the deep ocean and retrieving them presents all sorts of challenges. But once they're on board, what good are they? For Expedition 7, much of the corals' value lies in what they can tell us about the past -- recalling that history presents its own set of challenges.

In order to know anything about past climate from corals, we need to know their age. Ordinarily, scientists determine an object's age by measuring the radioactive decay of some element in it. Radioactive decay occurs when an unstable form of that element changes into a stable one by spinning off a part of its nucleus.

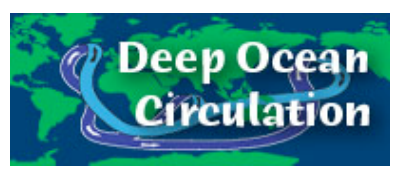


The uranium-thorium "age" of a coral is the age of the coral. The radiocarbon (14C) "age" of the coral is the age of the coral, plus the age of the water in which it grew. Subtracting the former from the latter gives the age of the water in which it grew. Scientists use this information to learn about the rates at which water circulates through the oceans.

Carbon is a useful element for dating objects because it's so prevalent in our environment. The unstable form, or isotope, of carbon is 14C; its stable, unchanging isotope is 12C, where the different numbers refer to different atomic weights. As 14C decays, the ratio of 14C to 12C changes over time. This change allows us to measure age.

We measure the rate of radioactive decay with what's called a half-life. 14C's half life is 5,730 years. This means that every 5,730 years, there's half as much 14C as there was in the previous 5,730-year period. To extend this concept, in 11,460 years, there's one-fourth the amount of 14C as there was originally.

Ordinarily, we measure the age of an object by comparing the current 14C/12C ratio with ratio of the past atmosphere, since that is where radioactive carbon comes from. The difference between the two is the age since it was formed. But with deep-sea corals, that difference is both the age since the coral was formed and the age of the water in which it grew.



The global ocean circulation system transports heat worldwide. Learn how differences in the temperature and saltiness of seawater drives deep ocean circulation »

Since we want to know both of these values, we face the classic problem of having one measurement and two unknowns. In such cases, you need to somehow determine one of those unknowns from another angle. In the case of the deep-sea corals, we get their age by analyzing another element they contain: uranium.

Like carbon, uranium is radioactive. As it decays, it changes into another element, thorium. Fortunately, while a coral is growing it incorporates a lot of uranium but no thorium. This

Fortunately, while a coral is growing it incorporates a lot of uranium but no thorium. This means that as it ages its thorium/uranium ratio increases at a known rate. So, measurements of the thorium/uranium ratio are measurements of the coral's age.

Now we know two things: time since the coral was formed (from uranium), and the sum of that time and the past water mass's age (from carbon). So, the difference between these two gives us the past radiocarbon age of the water.

Collecting fossil corals at different depths is like collecting water profiles today. The coral records in its skeleton all that we need to know. We just have to find the ways to tease it apart.

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