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Science AMA Series: We're scientists on a research ship to Antarctica. We're pulling up cores to look at the history of the West Antarctic Ice Sheet, and predict its future. AMA!

IODP R/SCIENCE

Hi Reddit, this is Rob McKay and Laura De Santis, co-chief scientists on the International Ocean Discovery Program (IODP) Expedition 374 to Antarctica. We're pulling up sediments from below the sea floor to look back in time about 20 million years to see how the West Antarctic Ice Sheet (WAIS) evolved up to the present day. With this information, alongside our model-making colleagues, we can predict the future of Antarctica. This is particularly important because Antarctica is the largest source of fresh water on the planet and could contribute about 200 feet of sea level rise! It's important to know how much the WAIS could contribute and when. To do this, a scientific team of sendimentologists, micropaleontologists, paleomagnetists, physical properties specialists, and geochemists have teamed up on the scientifici drilling ship the JOIDES Resolution for 9 weeks to drill thousands of feet below the sea floor and millions of years back in time.
Read more about the expedition here: https://iodp.tamu.edu/scienceops/expeditions/ross_sea_ice_sheet_history.html.
Looking forward to answering your questions!

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What are the primary proxies you'll be using and can any of them tell you about the rate of ice melt, hopefully to put some constraints on past Marine ice shelf and Marine ice cliff instabilities?

aClimateScientist

This is an excellent question. Of course the rate of ice melt is really what we all want to figure out. As you said, the proxies are our best way to get there in combination with modeling. For our expedition we will try to apply as many different proxies as possible. The combined expertise of scientists on the ship will allow us to use chemical, physical and biological proxies. For example, we will carefully study the lithofacies, their grain size, their inorganic and organic chemical composition, the assemblages of microorganisms, and more. I hope this answers your question.

What is your biggest challenge in working there?

MTBeach

The cold water proved to be the most challenging during this expedition. We had an ice observer to help us avoid coming to close to ice, but the ice was not very thick and did not pose a problem. The cold water affected the functioning of one of our propellors. After 5 weeks, the problem was significant enough to force us back to port in New Zealand.

Any genomics being done on the old core, possibly in ice melts or just in sediment? It would be interesting to see if there's any stray eDNA that's been preserved.

AdrianBlake

Ancient DNA of past life can be preserved in sediments, but we need extremely clean recovery and LOTS of material to do these types of analyses. The genomic work we are doing is actually about the microbes currently living beneath the seafloor. We collectively call this life (made up of bacteria, archaea and fungi) the "deep biosphere." These organisms have really interesting lifestyles like breathing metals or gases like methane. We'll look at metagenomics (who is there?) as well as metabolomics and geochemistry (what are they doing?) to see what life is like below the Ross Sea.

How do you intend to use the core samples you find? What is their specific value, aside from their general value as a curious window into the past, to your mission and modeling?

P.S. If you find a large, pyramid-shaped structure... please don't touch anything that appears xenomorphic in nature. Thanks!

adenovato

The core samples are used for many difference studies. The composition of the sediments tell us about how warm it was, how much life was present, how much material was being carried by ice bergs, sea ice, and large ice sheets, and how big the ice sheets were. The magnetic properties provide clues about how Earth's magnetic field works at high polar latitudes, where observations are sparse. They also provide a way of dating the samples. The very small (micro) fossils also help us determine the age and the environmental conditions. There are so many other things the physical properties, microbiologic data, etc. tell us.

Thanks for taking time to answer questions.

Can you say a bit about your safety protocols in such a remote and potentially icy environment, such as who gets to determine if you have to pull the string due to heavy winds, seas or ice?

Also, do you have any opportunity for shore excursions?

Wrathchilde

There weren't any opportunities for shore excursions.

We have an approved Polar Code Manual which specifies actions that need to be taken in polar regions. The captain of the ship is responsible for the enforcement of the polar code manual while in polar regions. We did have to relocate drilling because of sea ice encroachment. And we carried a full-time ice observer during the course of the expedition to assist in the tracking of ice and sea ice. The captain gets to determine if we have to "pull the string". In the area we were in on this expedition, the winds and sea were well within the limits of our operational capability.

So far, what has been the most interesting discovery you have made with these cores?

GTSPKD

The most mind boggling fact for many of us has been to see how much material we found down here in the Ross Sea that shows us the interplay of atmospheric and ocean temperatures, ice sheet growth

and decay, ocean circulation (the way the water moves around the oceans), and the building of the modern sea floor around here. If we look many million years back in time, what is now the deep sea was shallow ocean, and some of the shallow ocean was land. We see evidence for this in our cores, and can't wait to work out all the details about the stories when we get back home.

So how bad is the ice sheet really? It seems every year I read that the models are off and that it is accelerating melt more than we can predict. Also have you all seen any pattern of this in the past. Thanks

ndnkng

Understanding the response of the large ice sheets in Greenland and Antarctica to global warming and rising atmospheric carbon dioxide concentrations is a complex topic. Some areas of the ice sheets are more vulnerable to changing environmental conditions, and some are less. To give an example, when the ice is indirect contact with the ocean, it can melt from above (atmosphere) and below (ocean), which makes the melting go faster. This happens at the moment in some parts of the Antarctic ice sheet. With every year of research, we collect more data that document this change in more detail, and this is why you keep hearing 'new facts' on it. The bottom line is that we have known for quite a while that the ice sheets are changing, we just keep learning more about the details and processes on how it happens. Is it really bad? Well, if we continue to warm our planet it could lead to a lot of the ice on the poles disappearing. This is going to raise sea level to a level that many people living in coastal areas are affected. This is not going to happen overnight, but we really need to understand the exact mechanisms and rates at what is going on, to make sure we know what our future will look like.

Any advice for a young person who might want to do what you do? How did you get into this line of work?

KhaleesiCatherine

If you're a high school student or an undergraduate, get involved with any research that you can, especially if it involves field work. That way you will gain some experience and hopefully become interested in something that you can pursue as your career develops.

Any advice for a young person who might want to do what you do? How did you get into this line of work?

KhaleesiCatherine

Follow your passion and do what you want to do. I personally had a wonderful geography teacher at school, who made me aware of the field of Earth Science and geology. Then I learned that studying the chemistry of rocks is a very powerful way of learning how our planet earth changes. I have never looked back and feel very privileged to be a scientist. My dad always said that is you have passion for what you want to do and work hard you will get there. And that's what I believe as well!

Any advice for a young person who might want to do what you do? How did you get into this line of work?

KhaleesiCatherine

Hi. There are several scientists answering these questions, so I will give you what got me (Gary Acton)

started in science. I wanted to be a psychologist. My guidance counselor in high school suggested I go to pre-med studies in psychiatry, which required that I take a bunch of science classes. I took a geology class my Freshman year and decided I like that and math. After another 3 years of taking all kinds of geology and geophysics classes, I decided to continue to graduate school, where I learned to do research in the geosciences. My first big research project was to drill cores in volcanic rocks in the Mojave Desert in California. The magnetic signal recorded in these rocks was used to study how California deformed as the San Andreas fault formed. From there, I went to Woods Hole Oceanographic Institute to do a post doctoral internship. The main theme of the next 28 years was to do one research project after the other in order to learn more about how Earth's magnetic field works and how the tectonic plates move across Earth's surface. That is how I became a paleomagnetist.

Any advice for a young person who might want to do what you do? How did you get into this line of work?

KhaleesiCatherine

I took a crazy path into science. I was a musician and I liked being creative, but I never thought about a scientific career fulfilling me in that way. I saved my required science classes in college for last, thinking I would hate them, and ended up in Intro to Geology my last summer. I LOVED IT. Even though I didn't have a lot of the basic required classes, I switched majors and spent a little extra time in college to meet the degree requirements. A lot of people will tell you that you need a solid background in math, chemistry, physics or even biology to be a scientist, but there are lots of different on ramps to this career. My best advice to you is make sure you enjoy what you are doing, and you will find the skills you need along the way.

Can the effects of the climate change be seen?

sciwins

The effects of climate change are apparent even at the most basic level of just looking at the cores as they are split in half. There are beautiful drop stones and large rock fragments carried out to the outer continental shelf by icebergs from the past and by an ice sheet that extended to the edge of the shelf. Some intervals of the core are laminated with very fine grains of sediment carried by underwater currents. The grain sizes, grain orientations, and sedimentary structures all tell us something about the direction and vigor of past currents.

What is the oldest fossil you have found?

psemraujr

The oldest fossil found is an 18 million year old diatom. Diatoms are very small plankton made up of silica, like glass. They can only be observed by looking through a microscope.

Any proof of climate change in your samples collected?

moloveblue

Absolutely. The main reason we went down here is to document the changes in the past we were quite certain happened. And that's what we did. We found many layers of sediment that changed in their color and composition (chemistry, physical properties, magnetics, biological assemblage). In some of

our cores these changes happened over longer timescales of hundreds of thousands of years, and in some they happen much quicker. Detailed work back home will hopefully help us to add a lot of knowledge and understanding on climate change, and in particular about the Antarctic ice sheets and how they reacted to it and maybe influenced it.

Is global warming real and if so, how much is man-made?

LillyEpstein

Climate change is real and continuously happening. The goal of Expedition 374 is to study that climate change back about 20 million years ago. Back then, humans were not around to change the climate, but the climate was changing and sometimes very rapidly. The ice sheet that currently covers Antarctica has change in size numerous times over the past 20 million years. It has shrunk and grown in size owing to many factors: some related to Earth's orbit relative to the sun, some related to greenhouse gas variations, some related to plate tectonic motions, ocean circulation, and other factors. Although Expedition 374 is not studying current climate change, the results can help understand what is causing current climate change. Yes, current climate change is being driven by man-made activities, of that there is abundant evidence from many scientific studies. Other natural processes are involved. One of the goals of this and other science ventures that look at climate, it to unravel what all the processes are and how important each of them is at different times in Earth's past and future.