Science AMA Series: We're Scientists on a Ship off of the Coast of Australia researching the climate during the Cretaceous and how it is related to plate tectonics and volcanic activity. AMA!

IODP [1] and r/Science AMAs[1]

[1]Affiliation not available

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Abstract

The International Ocean Discovery Program (IODP) conducts scientific ocean drilling expeditions throughout the world's oceans in search of clues to Earth's structure and past. Right now we are currently in the middle of Expedition 369, sailing along parts of the southern and western coast of Australia. We are interested in finding out more about what the Earth was like during the Cretaceous Period when the Earth was experiencing an extreme greenhouse climate. During this time period, Antarctica had no ice cover and was actually attached to Australia. About 94 million years ago, they broke apart. Part of the expedition is also studying this plate tectonic movement. The scientists we have onboard who will be answering your questions include: Dr Brian Huber is one of the co-chief scientists for Expedition 369. He works at the Smithsonian National Museum of Natural History in Washington D.C. His research focuses on changes in global climate between 115 to 35 million years ago and the microscopic organisms called foraminifera during that time interval. Dr Richard Hobbs is the other co-chief scientist for Expedition 369. He is a professor in the Department of Earth Science at Durham University in the UK. His research focuses on understanding more about seismic waves and he's currently involved with several different projects that will help scientists better study and understand the seismic data they collect. Dr Vivien Cumming is a freelance writer and photographer focused on bringing science to the public. She has a background in Earth sciences with a PhD from Durham University and postdoctoral research experience from Harvard and McGill Universities. Lauren O'Connor is sailing as an organic geochemist, and her role is analysing gas from core samples and determining the amount of carbonate and organic carbon in the rocks we're drilling. She just finished her PhD at the University of Oxford. She is a palaeoclimatologist working on the Late Cretaceous (66-100 million years ago), reconstructing changes in ocean temperature, and how those temperature changes compare to changes in atmospheric CO2, ocean circulation, and the orbit of the Earth. Dr Lloyd White is a Lecturer in the School of Earth and Environmental Sciences at the University of Wollongong, Australia and an Honorary Research Fellow in the Department of Earth Sciences, Royal Holloway, University of London. Lloyd's research focuses on understanding how plates break apart and how mountains form in plate collision zones. The JOIDES Resolution is the only research vessel operated by the United States dedicated to scientific ocean drilling. As Us Anything!

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IODP R/SCIENCE

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How deep do you take core samples from?

How long does it take you to collect a sample?

Do you have alot of the same team members that are normal oil and gas drillship does, such as mud engineers, LWD, or whatever else?

What do you do with the holes you drill?

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What's the furthest offshore you could conceivably collect samples from?

Do you guys also collect sample data from cores that oil and gas drillship collect?

How's it going out there?

DuskGideon

Richard and Viv here:

How deep do you take core samples from?

The ship caries 8000m of drill pipe so we can operate in most of the oceans where water depths are typically 5000m. Typically IODP holes are limited 2000m below the seafloor.

How long does it take you to collect a sample?

It depends on how hard the rock is and how deep the water is. We are currently drilling 4000m below the ship and getting 10m of core every 2 hours.

Do you have a lot of the same team members that are normal oil and gas drillship does, such as mud engineers, LWD, or whatever else?

Yes we have a professional team of drillers that operate the drill rig but the analysis of the data is done by scientists.

What do you do with the holes you drill?

Once we have retrieved the rock core samples from the hole we refill the hole with mud. Some drill holes are re-drilled by subsequent expeditions. In those cases a re-entry funnel is left on the seabed in order to get back in the hole.

What's the furthest offshore you could conceivably collect samples from?

The ship can go anywhere in the ocean.

Do you guys also collect sample data from cores that oil and gas drillship collect?

Some of the scientists on board do but IODP don't as they have enough of there own core to worry about!

How's it going out there?

Very well thank you. It was a beautiful sunny day and we are collecting a lot of the samples we came here for and more.

Can you see signs underwater of some of the major historic floods on earth? Especially the 11,000 yr old one that flash melted the mini ice age glaciers with the meteor strike in the upper north american plate?

Can you indentify the previous coastlines 400 ft below sealevel around the world?

Any signs of animal or human civilizations or habitates at former waters edge?

Edit:

Regarding this:

Earth was experiencing an extreme greenhouse climate. During this time period, Antarctica had no ice

cover and was actually attached to Australia.

This seems counter intuitive. Wouldnt ocean levels have been higher if no icepack on antartica? Why would a land bridge exist or was it pre continental drift and unrelated to no ice?

azzazaz

Richard here: The JOIDES Resolution is designed to sample rocks from the mid-ocean whereas the evidence of the events that you are asking about would be found in the coastal areas.

This seems counter intuitive. Wouldnt ocean levels have been higher if no icepack on antartica? Why would a land bridge exist or was it pre continental drift and unrelated to no ice?

At the time we are investigating (the Cretaceous, over 65 million years ago) Australia and Antartica were joined as one continent. Sea level would have been higher with no ice.

Congratulations on finishing the PhD soon-to-be Dr. O'Connor!

For everybody... how will understanding global climate changes in the Cretaceous period help us better understand our climate today?

sciencereader3455

Brian here: Detailed study of the Cretaceous climate record helps inform us on how the climate-ocean system operated in the past, which will help us create more accurate climate models that will help us better predict the climate of the future.

Why foraminifera? Is it because of the abundance of remaining fossils?

What do they tell you? Are they a useful proxy for something?

adenovato

Lauren here: the different foraminifera present (or absent) can tell you a lot about the environment – water depth, oxygen conditions, light conditions, nutrient conditions etc. The shells of the forams can also be used for geochemistry – the carbonate from which they're made can be analysed for oxygen and carbon isotopes, which can tell you about the temperature and salinity of the water, the depth at which the critters lived, changes in the carbon cycle. The analysis of different metals in their shells can tell you even more! Forams are great for palaeoclimate work! We also look at a lot of other fossils though, everything we can find in the core, not just forams.

Ultimately, what do each of you wish to find on this research trip? What would make this venture a success in your mind?

adenovato

Brian: Based on what we have recovered I expect we will fill in some critical gaps in the ancient climate record so we understand exactly when the onset of the "hot greenhouse" Earth initiated, how long it was sustained and when the onset of the cooler greenhouse began.

Lloyd: I'm hoping to learn more about the early stages of when the Australian, Indian and Antarctic plates started to move away from one another. For instance, if we core ancient lava flows we can determine their age and that will help to tell us when this process started happening.

Lauren: My goal is to reconstruct a variety of climatic processes – temperature, CO2, ocean circulation, and how changes in the earth's orbit affect climate. For this expedition to be a success, I need the samples we collect to be of the right age (so far, so good), and to contain the right materials for the methods I use to be viable (again, probably good).

Richard: I want to calibrate the seismic images of the basin, so coring boreholes provides the ground truth as to what causes the reflections I see and what ages the rocks are in the subsurface. With that information I can then map the subsurface geometries which will feed into understanding how Australia, India and Antarctica separated.

Dr. Cumming,

Where will you be sharing your work science communication work? Is this a normal experience for you in helping bring science from the far reaches of the globe to the public?

What angle do you think most enticing and effective to convince general readers that this research is worth reading and understanding?

adenovato

Hi! Viv here: I will be sharing my work on my website and on the JOIDES Resolution website.

I wouldn't say this is a 'normal' experience for me as I spend most of my time in the field with scientists on land and this is my first time at sea, but it has been and is continuing to be an incredible experience working with a large number of scientists collaborating in what is effectively a big floating lab unlocking secrets from the below the seafloor. One of the great things here is doing daily live broadcasts to schools and watching the kids excitement as they get to see around the ship and labs.

The angle I love here is that we are looking at rocks buried below the seafloor, an area that makes up most of our planet but is still very much unexplored. The rocks down there contain answers to many geological questions and answering these questions is key to understanding the future of our planet.

how often do you get fossils or parts of fossils in a core sampling?

PotatoVarnishOrigin

It depends on the kind of rocks we are pulling up, but if they are sedimentary rocks that were once deposited on the seafloor then often all the cores can have some kind of fossil in them, even if its just one!

How can I get on the Resolution? I have a geology maths double major, Graduate Certificate in Environmental Management. Interested in Glaciology and how this informs our knowledge of our climate.

LarysaFabok

Hi, Lauren here. You have a couple of ways: 1) you can apply as a tech through theIODP website, or 2) you can find an expedition that fits your interests and apply for a particular position onboard.

What modern region of the world do you believe Antarctica most resembled during the Cretaceous period?

adenovato

Lloyd here: It would have been a temperate climate similar to areas around Sydney or San Francisco. Though it is a large continent so it would probably have spanned multiple climatic zones.

How effective is core sampling for extrapolation of climate data? What spoils a core?

scienceaccount103040

Richard and Viv here:

How effective is core sampling for extrapolation of climate data?

In the oceans obtaining drill core is the only way to sample the state of the oceans and climate in the geological past and generally core provides a continuous record of climate so it is very effective.

What spoils a core? In some cases drilling conditions are not ideal so core cannot be recovered. The core can also get broken but we take great care to maintain the samples in their correct order.

What exactly are "seismic waves" in this context? Are we talking about wave motion through matter say like how kinetic energy moves through land during an earthquake?

scienceaccount103040

Richard here and here's a video we made that should explain it nicely!

Is it conceivable that - if humans buried large amounts of CO2 from carbon capture under the earths surface - it could cause tectonic disturbances?

junzip

Lloyd and Richard here: Typically where they are thinking of storing CO2 is in areas that are tectonically stable therefore it is highly unlikely. However the unloading caused by the melting of the Greenland and Antarctic ice sheets is predicted to cause the release of tectonic stress in those areas that will result in earthquake activity.

Do you mind me asking about the political atmosphere surrounding environmental sciences? Have you seen a marked shift in how your field is treated, and in what ways? I only ask because some of you are US based, and the government has taken a notably different position about environmental sciences than previous administrations.

Is there anything we can do to help combat that?

sphonino

Richard here: As scientists there is wide agreement about the current state of the climate and what are the primary drivers. However, our prognosis places the political leaders in a dilemma. Climate is a long game, hundreds to thousands of years, human life and political careers are a short game, a matter of years. Unfortunately most politicians can only see as far as the next election and only have a passing interest in the longer term well-being of the human race. Essentially their molecules will have been recycled long before the effects of any of their short-term politically motivated 'quick-fix' decisions come

home to roost. As a society, we need to change our expectations and as a community take responsibility to start to ween ourselves off of dependence on fossil fuels. Though the politicians can play games with 'binding' agreements ultimately we have the control through peer pressure and purchasing.