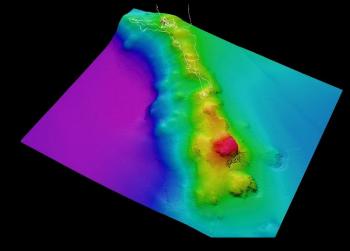
## Discovering the Deep: geophysical tools for identifying biodiversity hotspots in the deep ocean







Rachel Lauer and Robert Perrin Earth@UCalgary University of Calgary

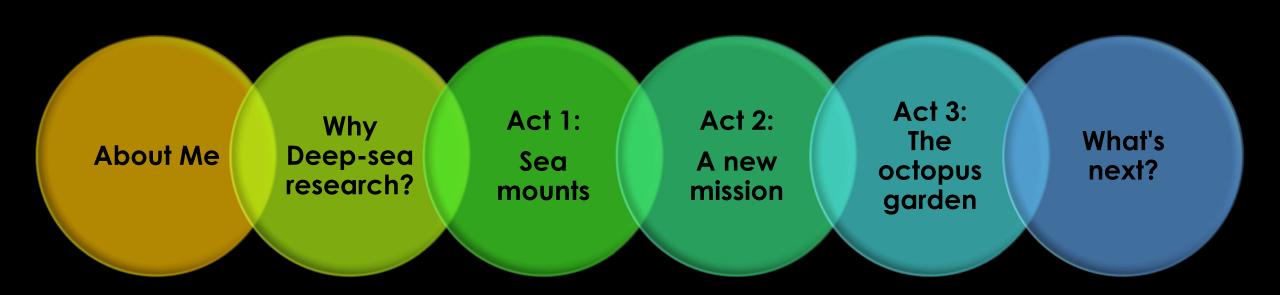








## Roadmap



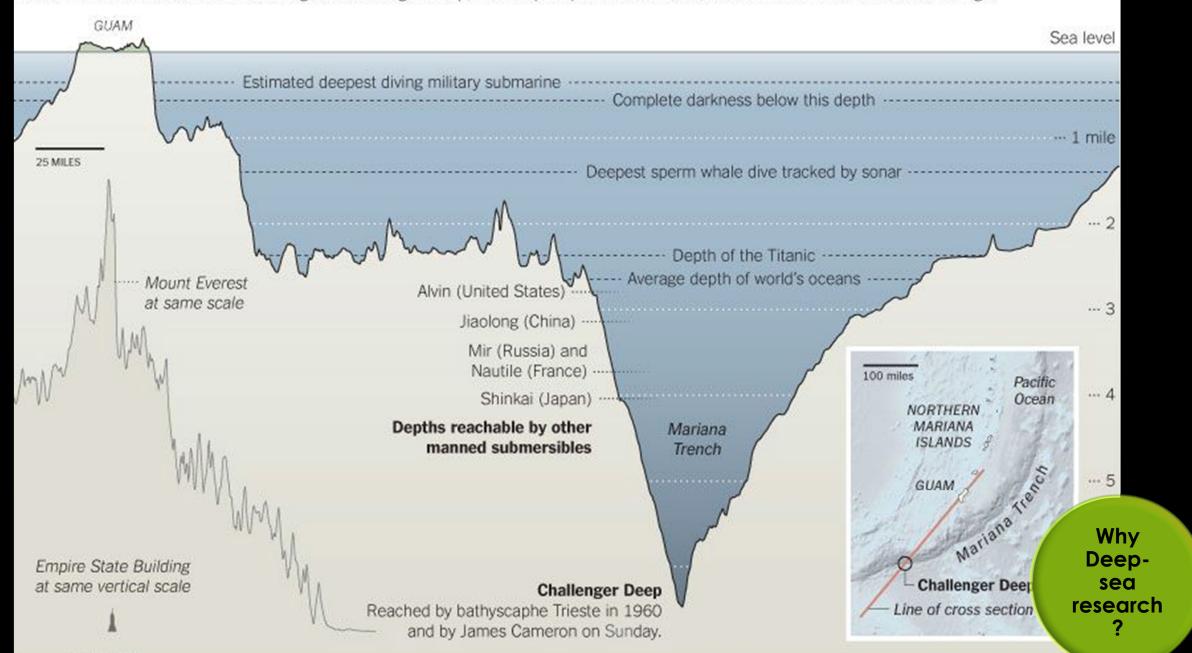
DAY 44:
STILL STRANDED, WITH
NOTHING BUT FLAT EMPTY
WATER AS FAR AS THE
EYE CAN SEE.

Why Deepsea research ?



#### Deep Dive

James Cameron succeeded in reaching the Challenger Deep, the deepest part of the ocean, in a mini submarine of his own design.



Sources: NASA: NOAA



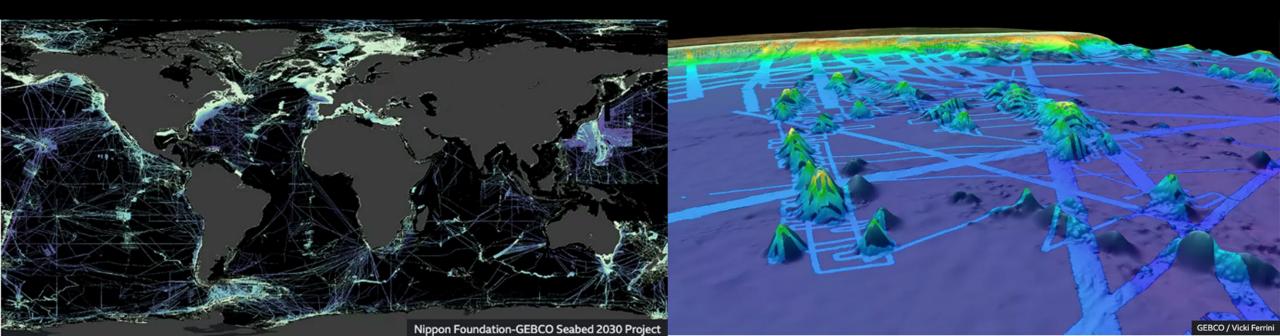
## Importance of ocean exploration and marine research

👺 The ocean makes up 71% of the Earth's surface, and >95% of all habitable space on Earth

The five main oceans contain 94% of the world's wildlife and 97% of all the water on our blue planet

~20% of the seafloor has been mapped with modern multibeam/sonar measurements

Humans have physically seen or been to < 5% of the seafloor





## Importance of ocean exploration and marine research

We have higher-resolution maps of the surface of our moon and Mars
Mapping helps us understand ocean currents, marine habitats and biodiversity, seismic hazards
Human health and marine research: e.g. treatment of leukemia, pain relief, PCR, fluorescence
Deep time and evolution: many branches of life that have evolved over 4BY





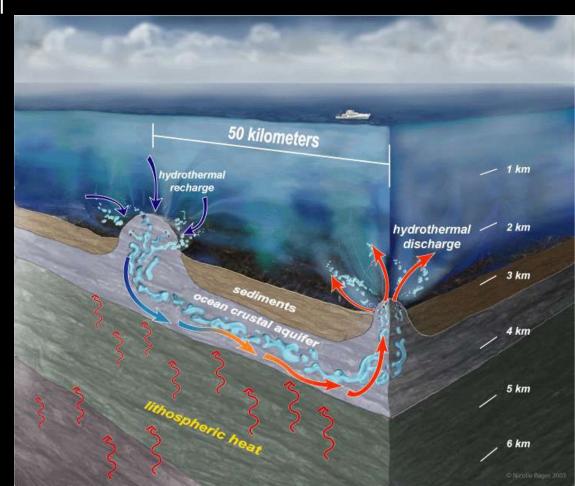


## Seafloor hydrogeology influences:



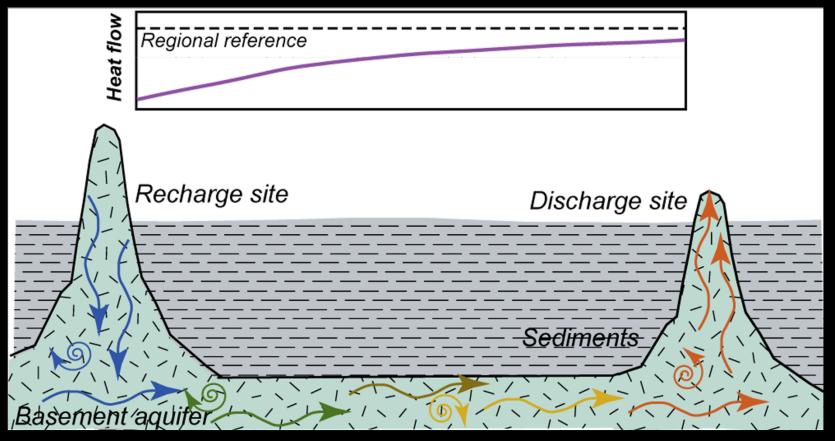
the physical state and evolution of the crust heat loss and thermal evolution of crust chemical composition of the oceans maintenance and evolution of biological communities, within and above the crust

Movement of fluids in and out of the oceanic crust driven by hydrothermal circulation



## Hydrothermal circulation is primarily driven by:





modified from *Fisher and Wheat* (2010)

## ...the "hydrothermal siphon"

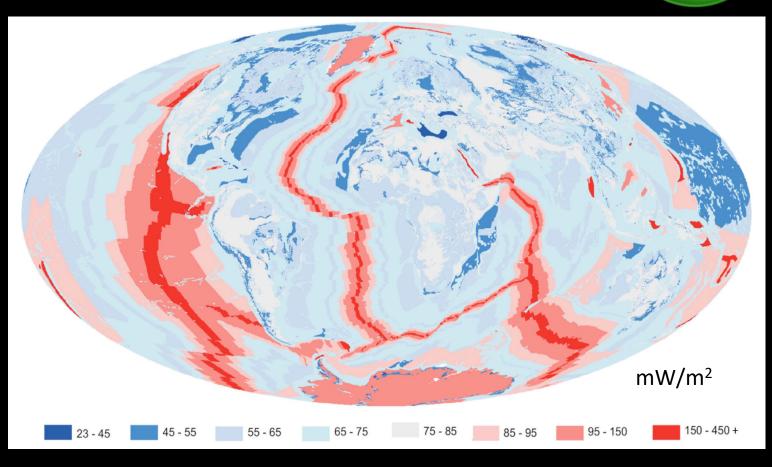
Magnitude of driving force depends on: depth of circulation (sediment thickness, aquifer thickness), temperature difference between recharging and discharging fluids, flow rate (coupled system)

### Hydrothermal circulation via seamounts:



- Accounts for 8-10 TW of heat loss globally (18-20% of Earth's total heat loss)
- Recycles the crustal reservoir every 1k-10ky
- Recycles the entire ocean every 100k-500ky

How do we know this? Heat flow data!



The location Costa Rica Dorado

10.5 °N−

10 °N-

9.5 °N

9 °N-

8.5 °N−

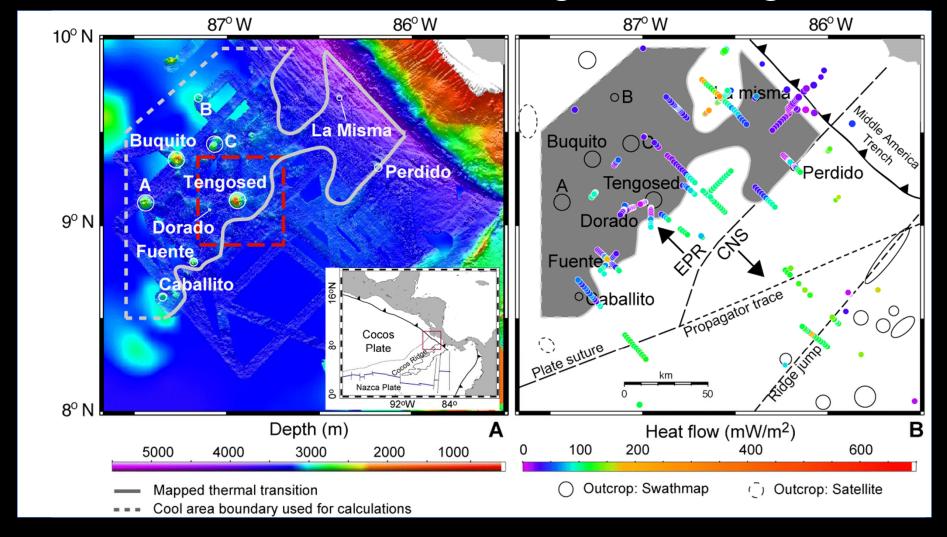
-Fuente

Unnamed Outcrops

Caballito

Act 1: Sea mounts

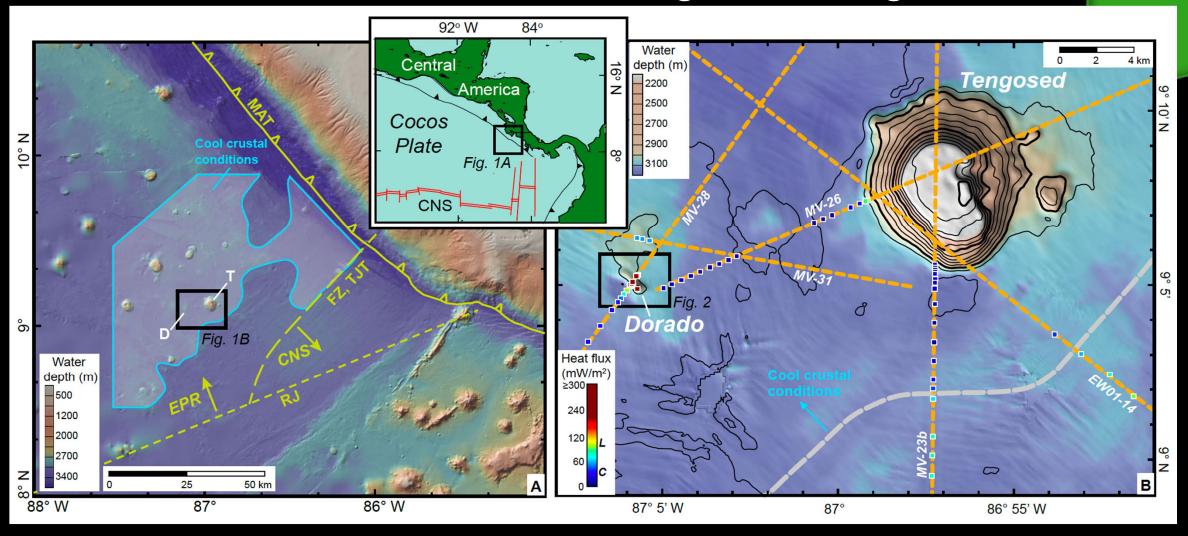
### Heat flow surveys in 2001/2002 identify a large "chilled" region of the seafloor



Modified from Hutnak et al., 2008

- Eleven (11) outcrops within area the size of Connecticut is missing ~70% of lithospheric heat
- Mean conductive seafloor heat flux of chilled region is ~30 mW/m²
- Very high fluid flow rates inferred...but what rates are required? Is this reasonable?

### Heat flow surveys in 2001/2002 identify a large "chilled" region of the seafloor



- Eleven (11) outcrops within area the size of Connecticut is missing ~70% of lithospheric heat
- Mean conductive seafloor heat flux of chilled region is ~30 mW/m²
- Very high fluid flow rates inferred...but what rates are required? Is this reasonable?

# AT26-09: Dorado Expedition, 4–23 December 2013 (geology, geochemistry, geophysics, microbiology)



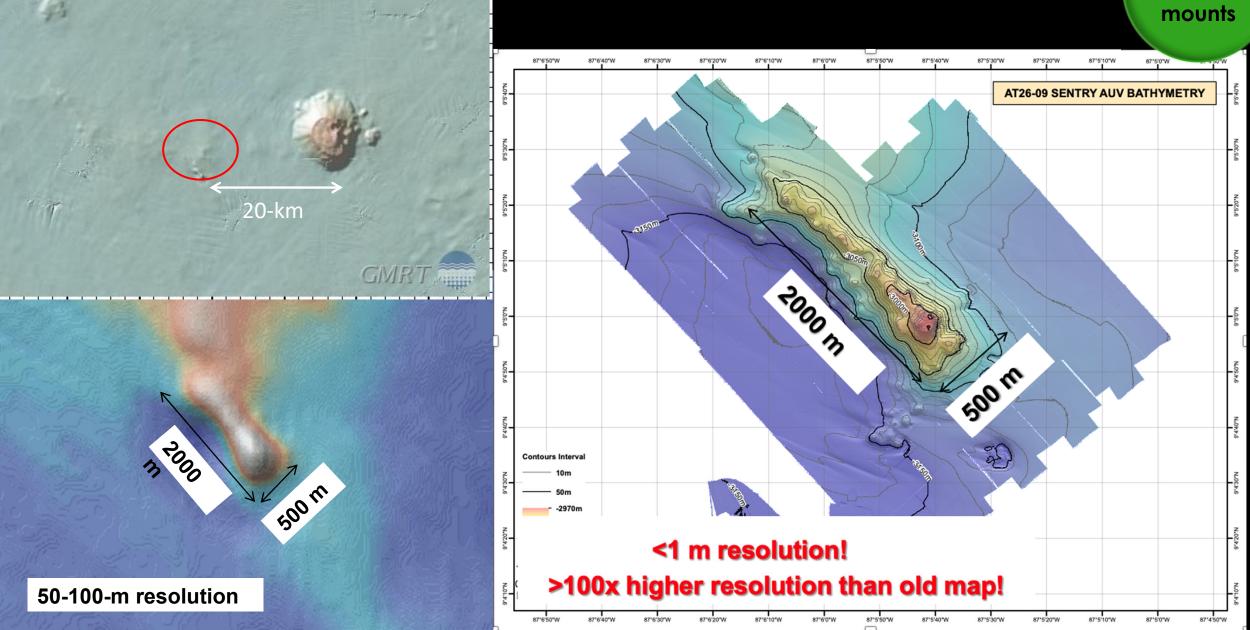


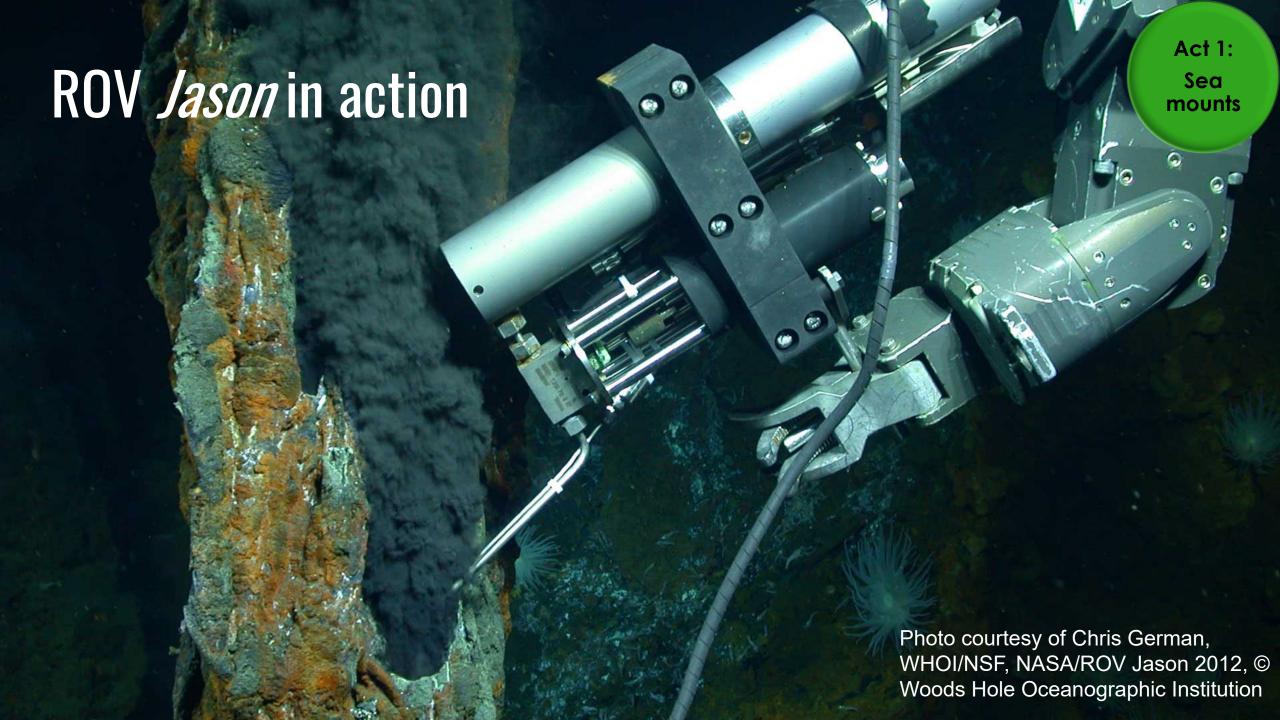
AUV Sentry used to map seafloor, measure water column data, profile sediment thickness

ROV Jason used to video/photograph seafloor, collect thermal data, fluid/rock/sediment

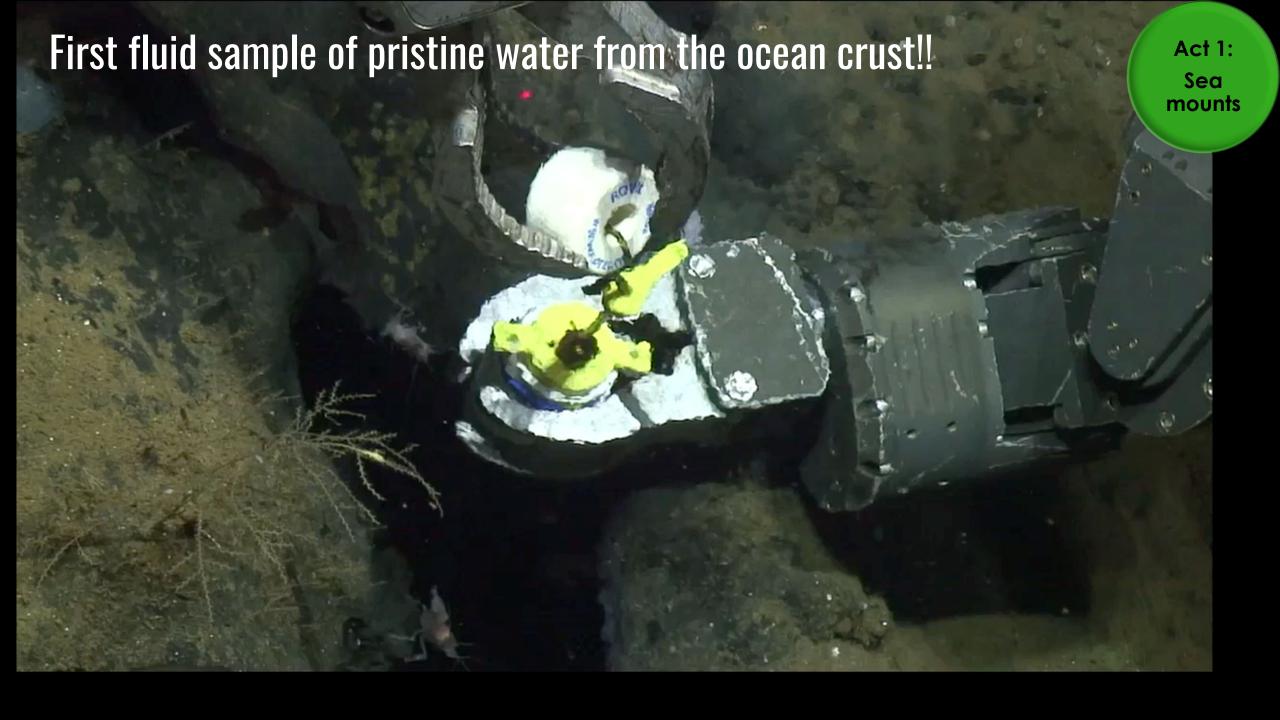
Bathymetric data used to plan 2013 expedition vs new data

Act 1: Sea mounts









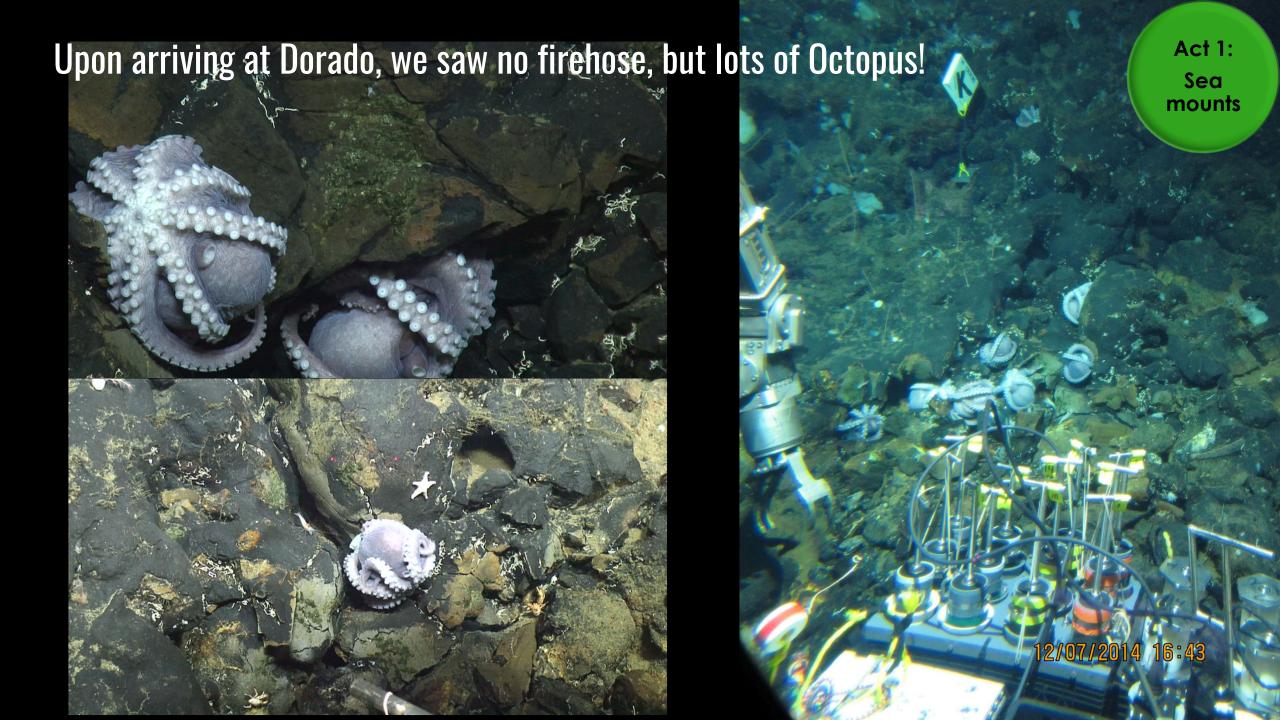
# AT26-24: Dorado Expedition, 11/30-12/12 2014 (geology, geochemistry, geophysics, microbiology)



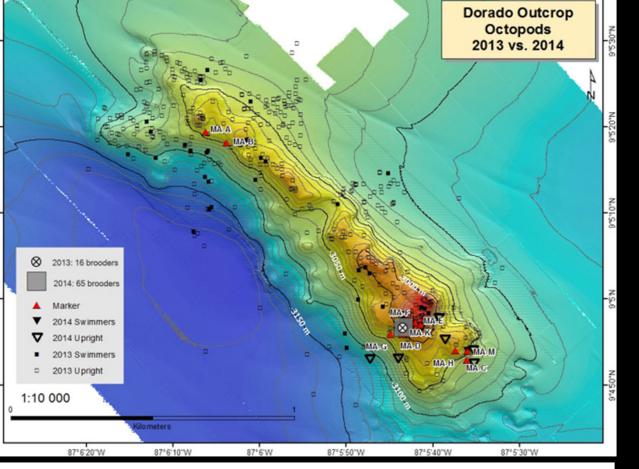




It turns out there was more than just hydrothermal flows....



Lots of shimmering water, shrimp, tube worms Act 1: Sea mounts





Deep Sea Research Part I: Oceanographic Research
Papers

Volume 135, May 2018, Pages 1-8



Clusters of deep-sea egg-brooding octopods associated with warm fluid discharge: An ill-fated fragment of a larger, discrete population?

Anne M. Hartwell a A M, Janet R. Voight M, C. Geoffrey Wheat M



Data from 2013/2014 were compiled and published: a new high-res map and the first study of clusters of deep-sea octopods....

But the findings predicted that the eggs would not survive due to stress, low oxygen ©

### Water escaping from the octopus-lined cracks was 8-10°C

Act 1: Sea mounts



# A flurry of articles featured the discovery but with dire predictions for the octopus nursery



Smithsonian MAGAZINE

#### Colony of Beautiful, Doomed Purple Octopuses Found Off Costa Rica

Hundreds of unidentified cephalopods were found nursing their eggs near a deep-sea vent

**Jason Daley** 

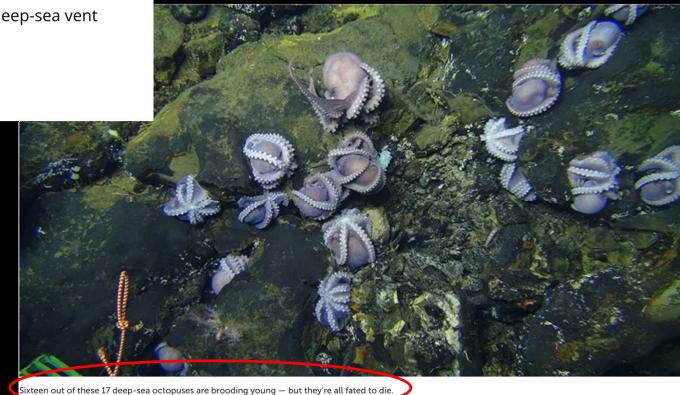
Correspondent April 20, 2018

**ScienceNews** 

WILD THINGS

ANIMALS

How a deep-sea geology trip led researchers to a doomed octopus nursery



Sixteen out of these 17 deep-sea octopuses are brooding young – but they're all fated to die.



## Ship time proposal funded through SOI, with Costa Rican partners



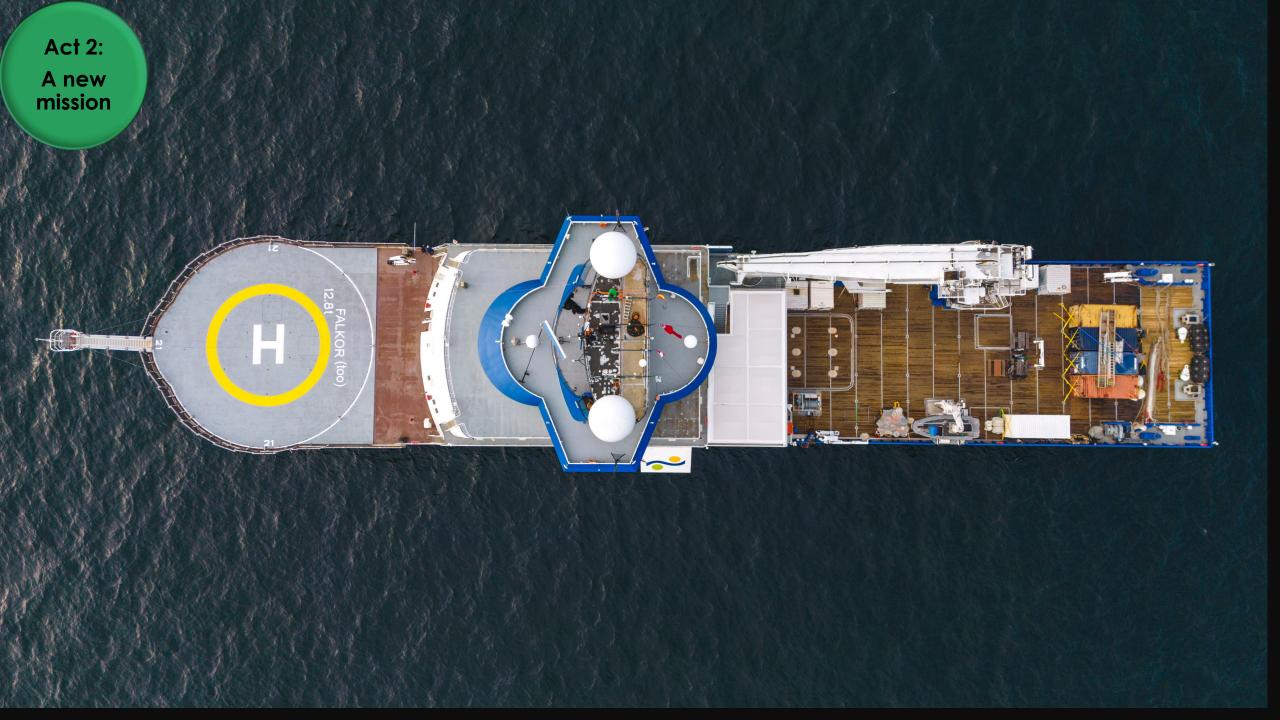
#### **Our Vision**

The world's oceans understood through technological advancement, intelligent observation, and open sharing of information.

Our Mission: We combine advanced science with state-of-the-art technology to achieve lasting results in ocean research, to catalyze sharing of the information, and to communicate this knowledge to audiences around the world. We foster a deeper understanding of our environment.

Schmidt Ocean Institute is a 501(c)(3) private non-profit operating foundation established to advance oceanographic research, discovery, and knowledge, and catalyze sharing of information about the oceans.





Act 2: A new mission



#### Act 2: A new mission

#### **TEAM**



Jorge Cortés-Núñez
CO-CHIEF SCIENTIST



Beth Orcutt
CO-CHIEF SCIENTIST



Diva Amon



Odalisca Breedy Shadid



Sergio Cambronero



**Emily Cowell** 



Tim D'Angelo



Maila Guilhon



Julie Huber



**Rachel Lauer** 



**Holly Lutz** 



Wendolyn Matamoros-Calderón



Beatriz Naranjo



**Rob Perrin** 



Gustavo Ramírez



Celeste Sánchez-Noguera



María Isabel Sandoval



Miguel Semedo



Janet Voight



Michel Droge
Artist-at-Sea



Carlos Hiller
Artist-at-Sea



Alex Ingle

Multimedia Correspondent





### The scientific goals:

Exploring the relationship between lowtemperature hydrothermal venting and octopus brooding

Understanding biodiversity and ecosystem function more broadly

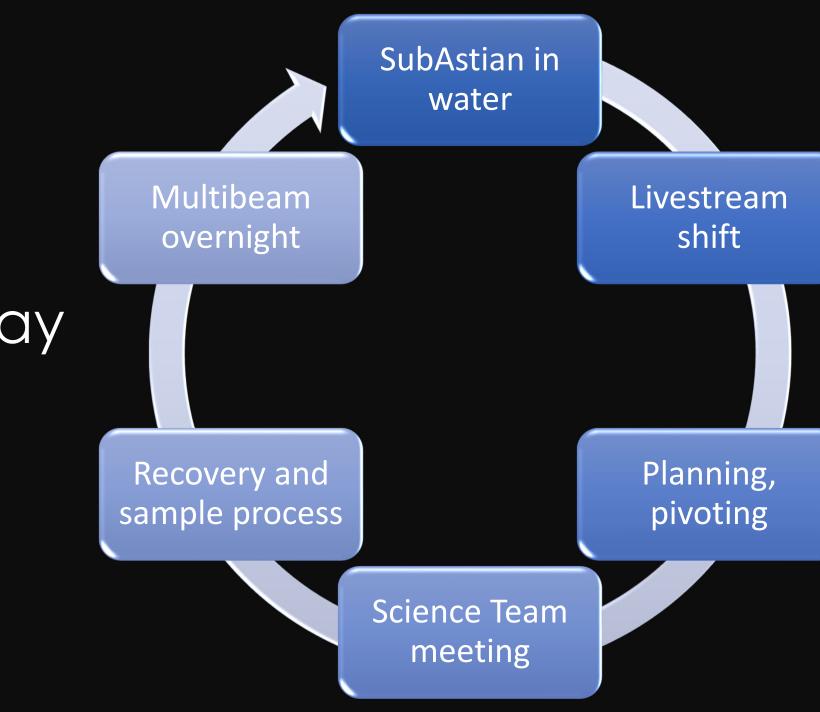
The dive plans targeted six seafloor features, five of which had never been explored previously



## Leaving port in Puntarenas, CR



Act 3: The octopus garden



Workflow-a day on the ship

5:00AM!!

SubAstian in water

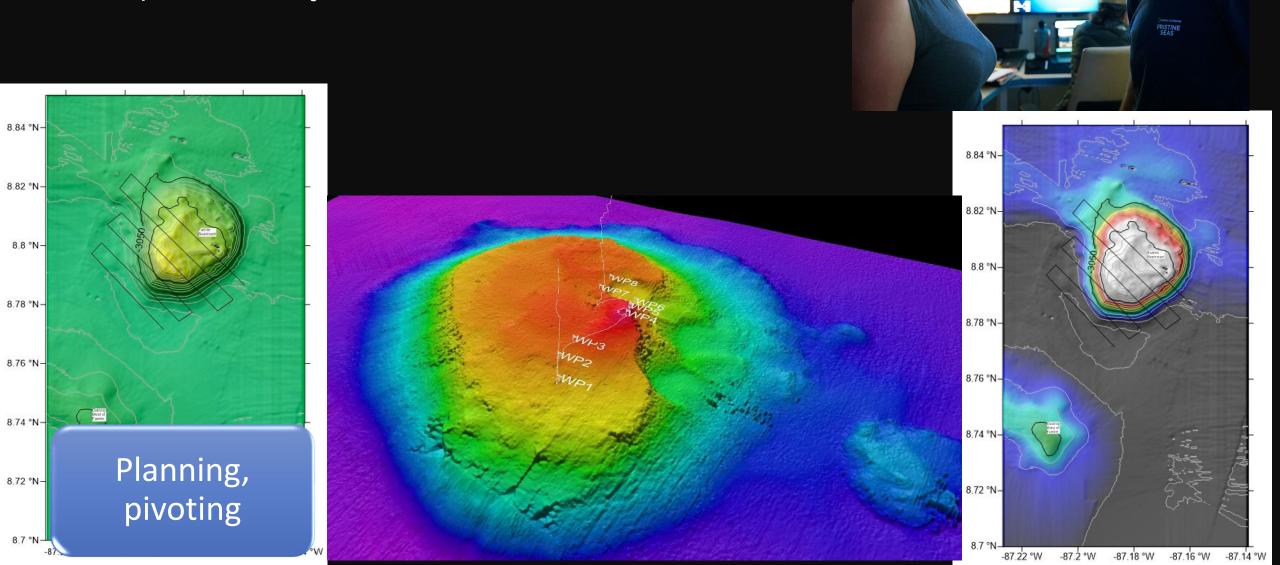








Mapping and dive planning incorporated **all** of the participants disciplines, objectives



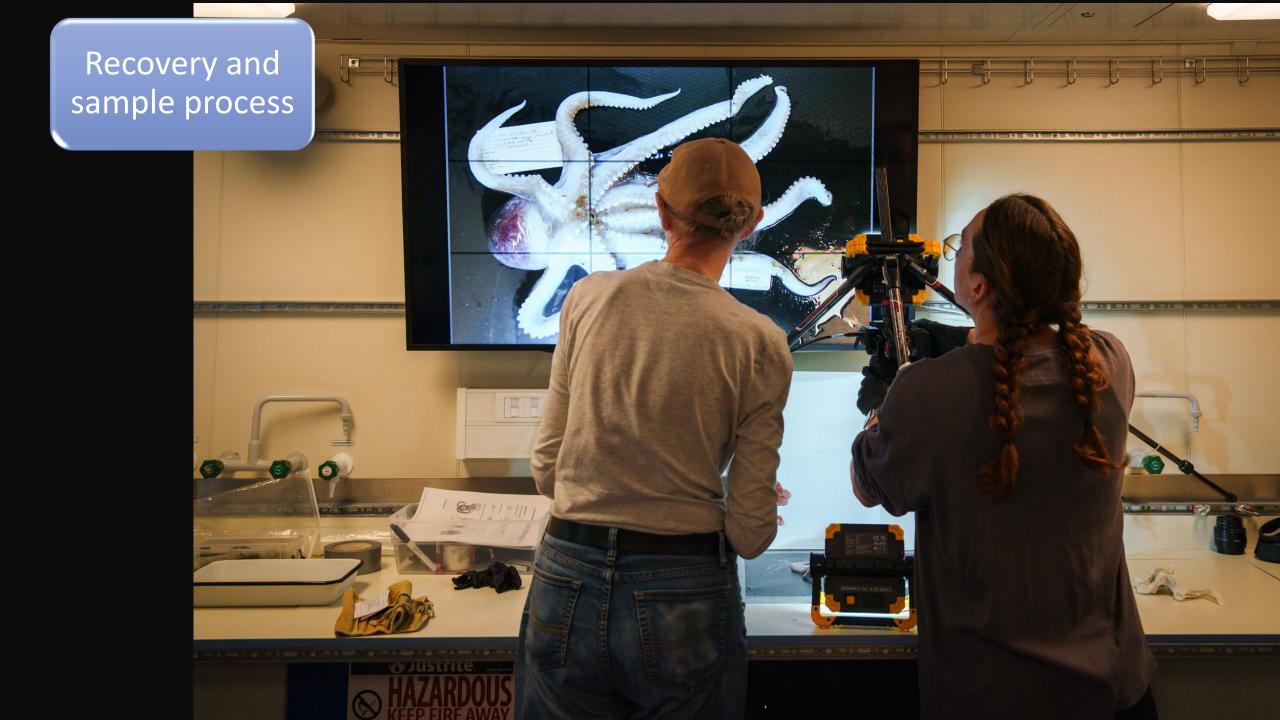
Science Team meeting

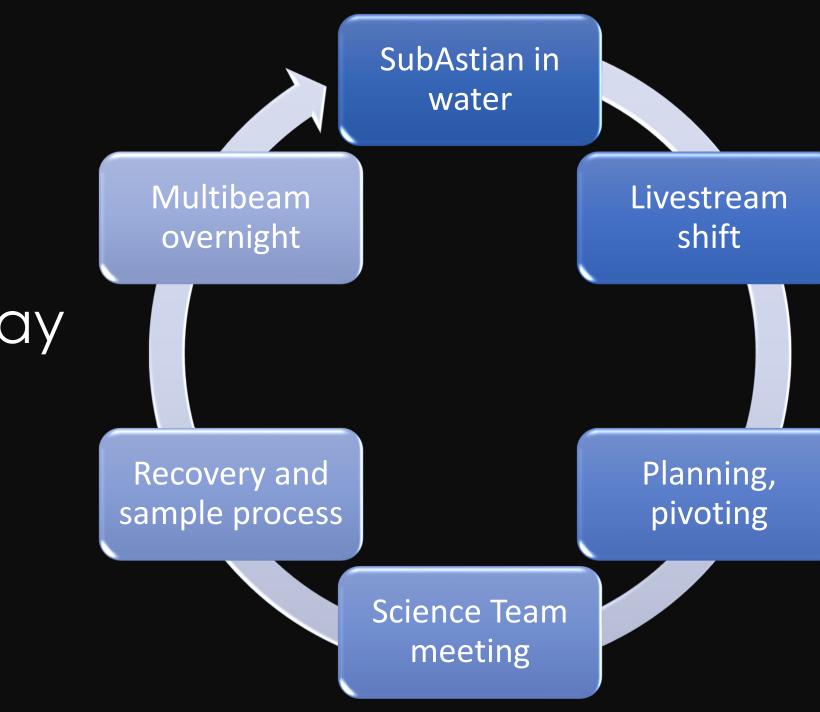
7PM!!



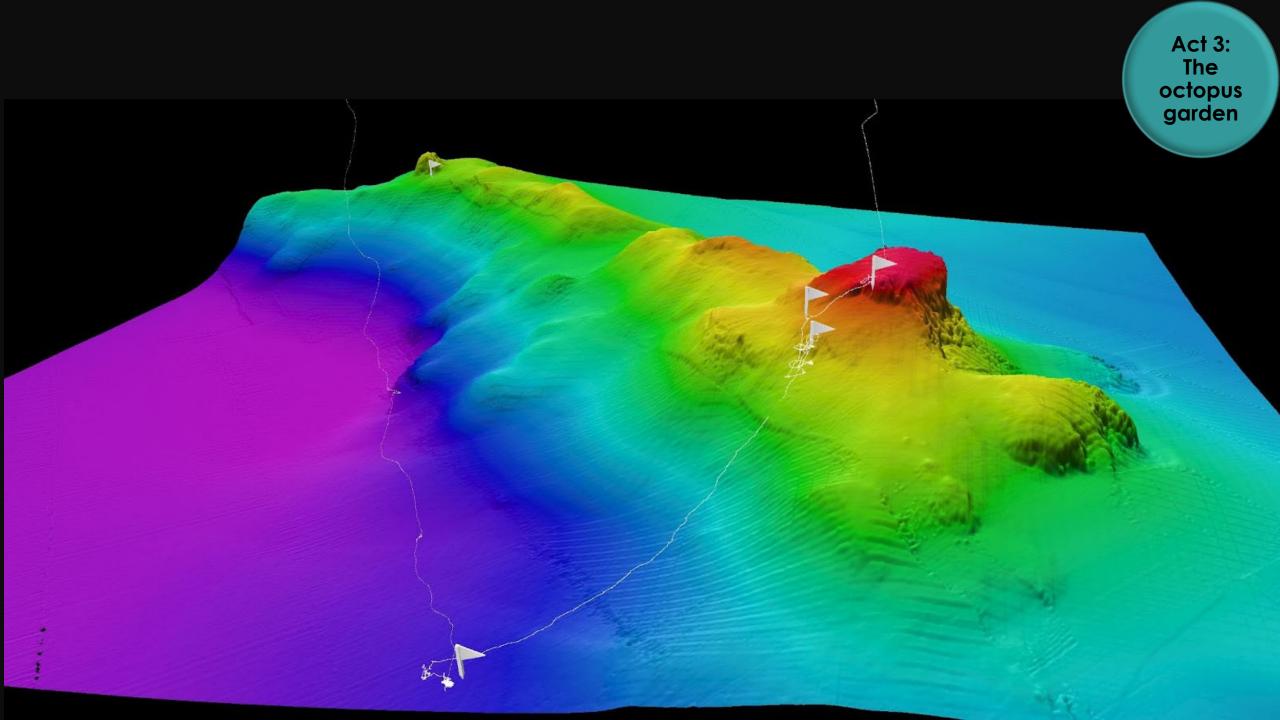








Workflow-a day on the ship







APPLY

**PUBLICATIONS** 

**EDUCATION** 

GALLERIES







next?

**ABOUT** 

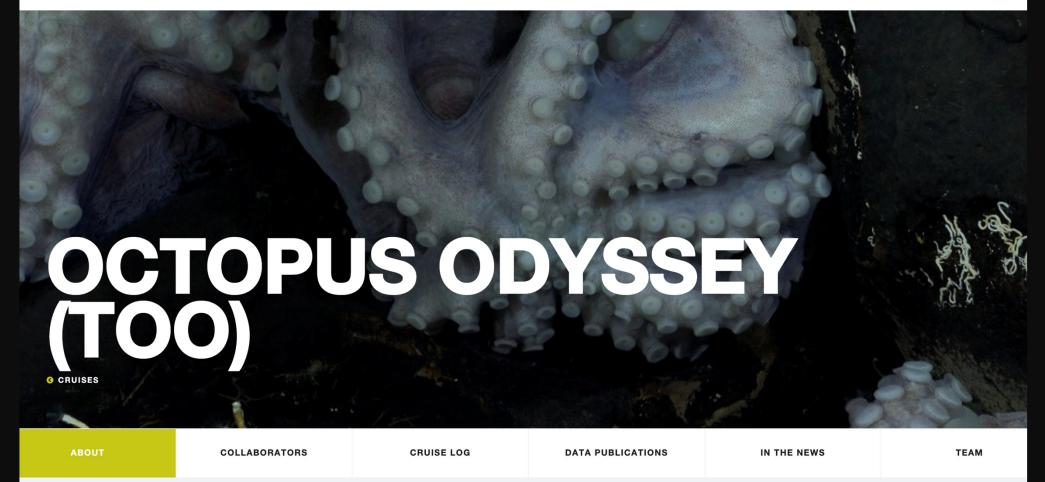
**CRUISES** 

**TECHNOLOGY** 

R/V FALKOR (TOO)

**ROV SUBASTIAN** 

**NEWS** 



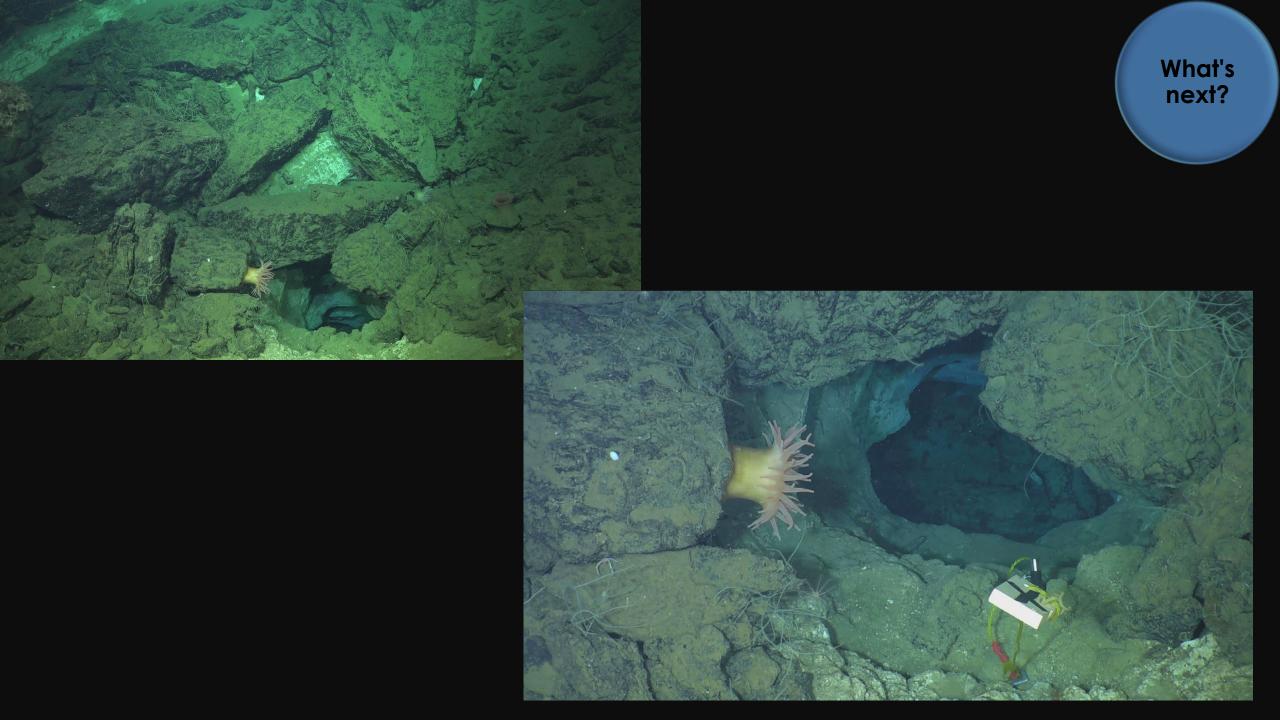
Expedition dates: December 2nd- December 15th, 2023

# THANK YOU

## ACKNOWLED GEMENTS



Most of the shipboard images were taken by @alexinglephotography







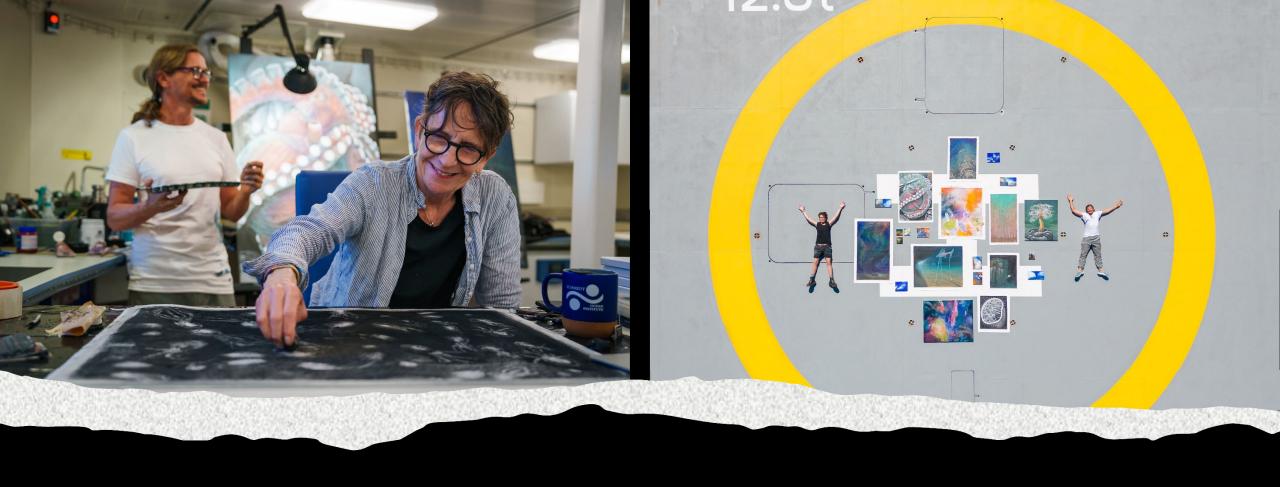
#### Almost daily outreach events-- Ship to Shore live casts











Artists at sea: Michel Droge (Bates College, right) Carlos Hiller (Costa Rica, left)

#### Something wondrous

#### **/XIOS**

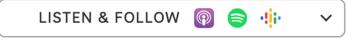
### LIVESCI=NCE

Watch rare footage of with 'remarkably full



SCIENCE





JULY 3, 2023 | 4 MIN READ

Deep-Sea N

**MEDIO AMBIENTE** 

of Muusoctopus.



Elated researcher hydrothermal ver

### **Newly Explo** the Third Ev

A recent expedition to the wa

By Ed Cara Published June 29, 202

Hallan en Costa Rica una peculiar eclosión de bebés pulpos de aguas profundas

Se trataría de una nueva especie de Muusoctopus, según los científicos coodirectores de la investigación

s discover never-beforep sea octopus nursery

new active octopus n



**EL**MUNDO













ado Outcrop



SOI Imagery https://creativecommons.org/licenses/by-nc-sa/4.0/





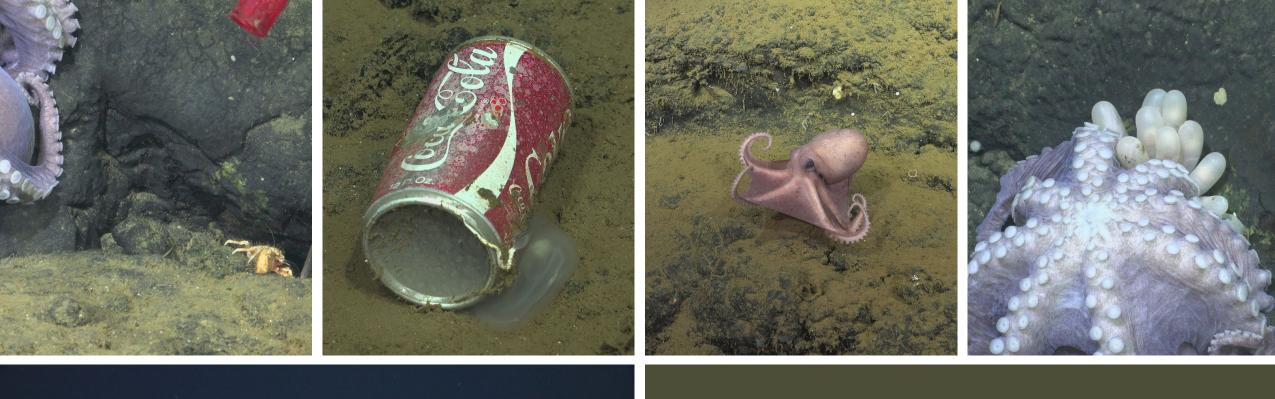




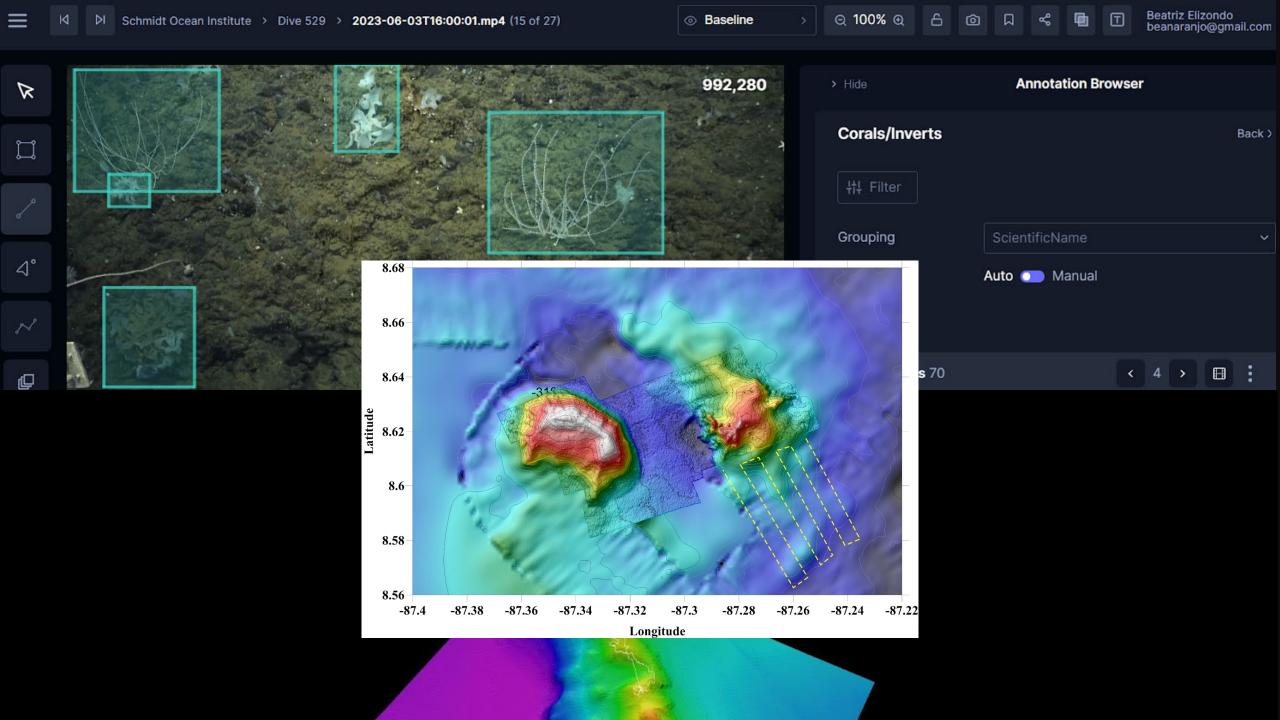


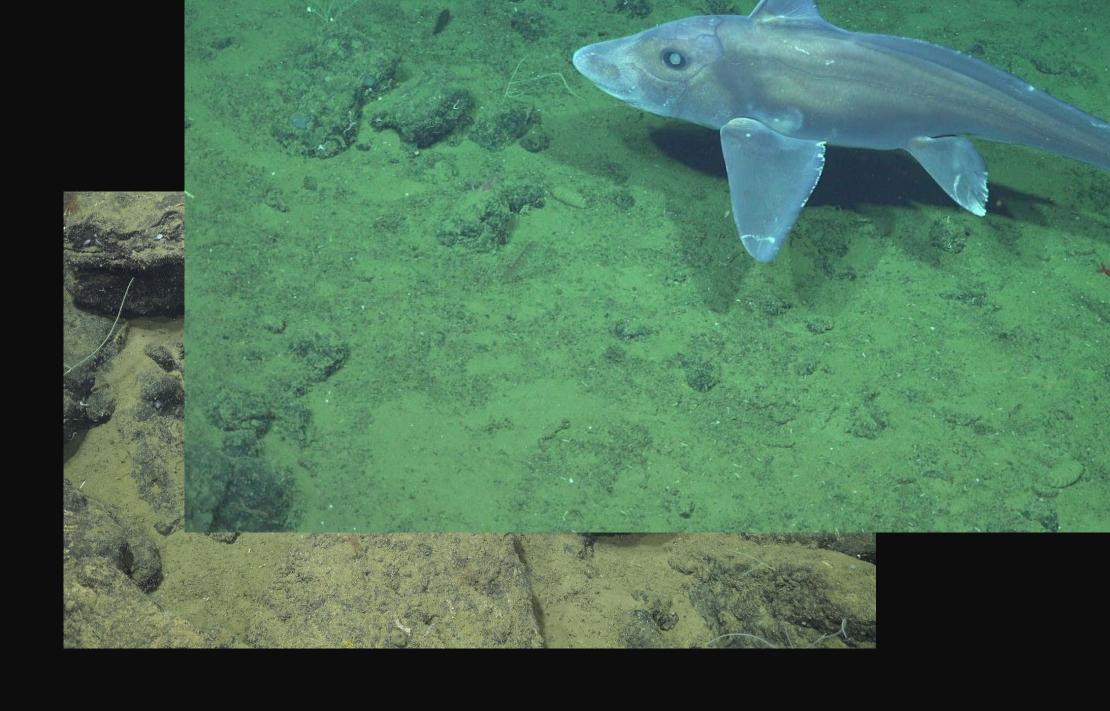












View of White OsmoSampler prior to recovery

