OCEAN OBSERVATORIES INITIATIVE

Regional Cabled Array

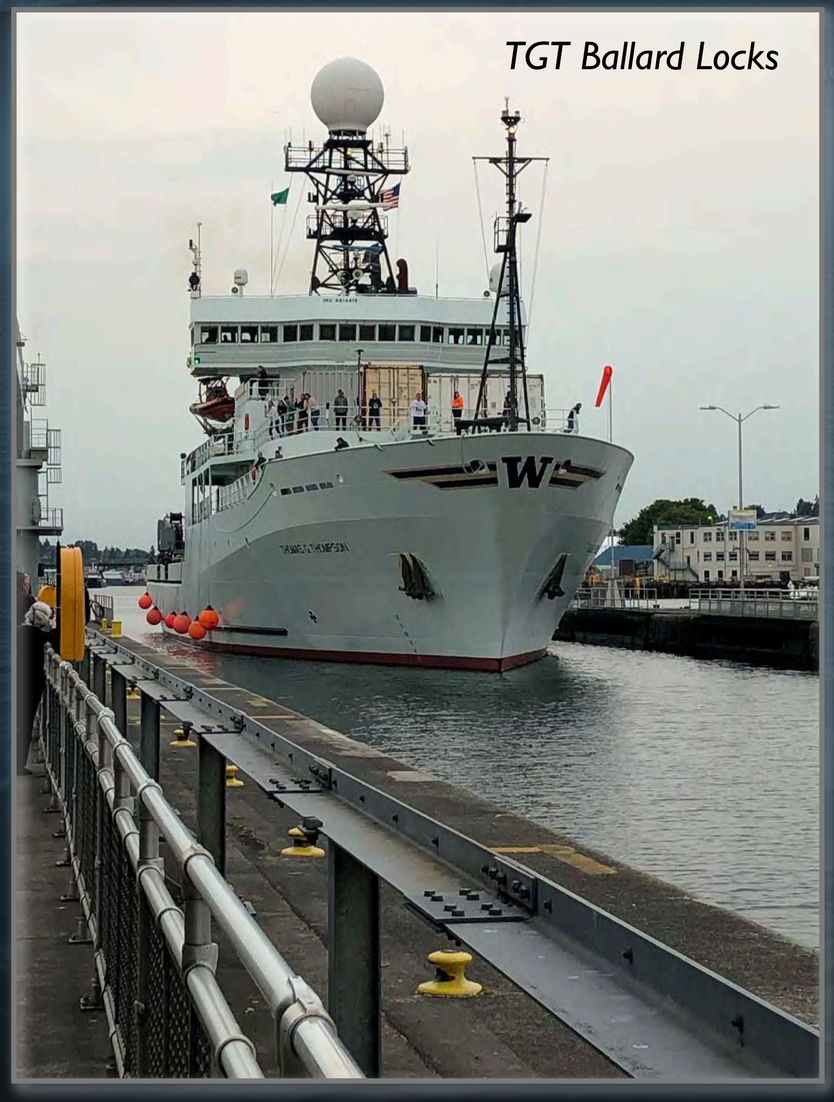
Debbie Kelley and RCA Team, University of Washington

OOIFB Dec 7, 2021

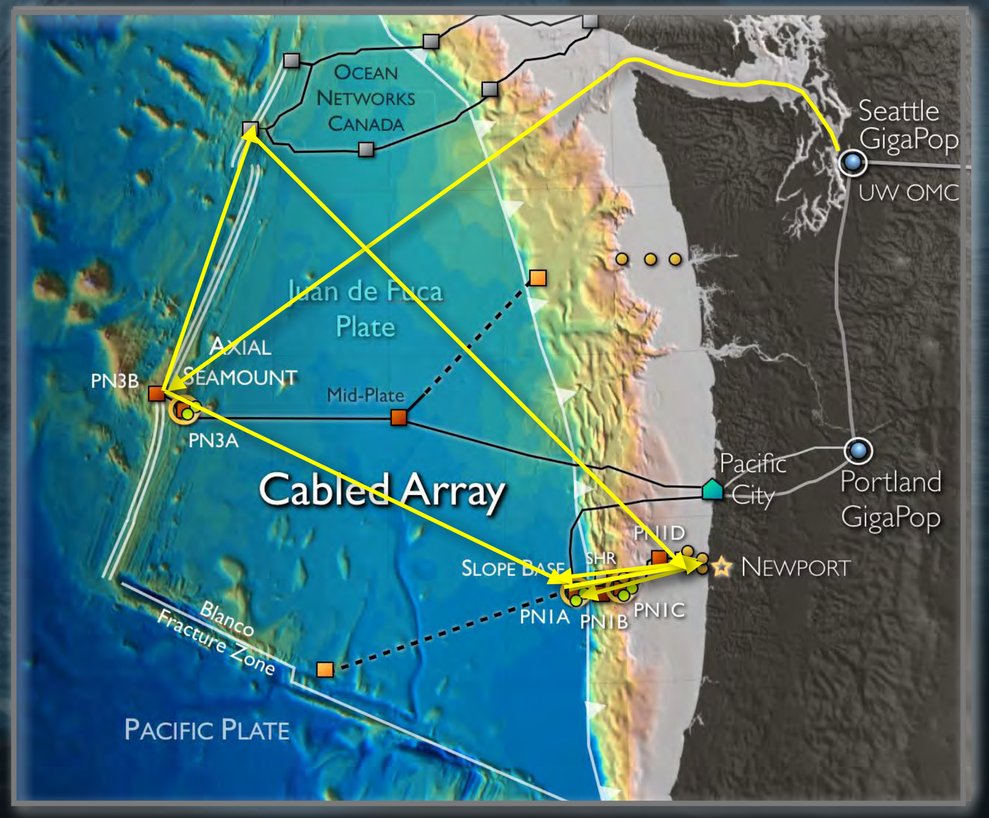
OCEANOBSERVATORIES.ORG

NSF

Regional Cabled Array Status Update


TGT Ballard Locks

Spring-summer focused on Operations and Maintenance Cruise (VISIONS'21) onboard the R/V *Thompson* with ROV *Jason* (July 30 - September 4, 2021)



Recovered/redeployed >200 instruments on the array

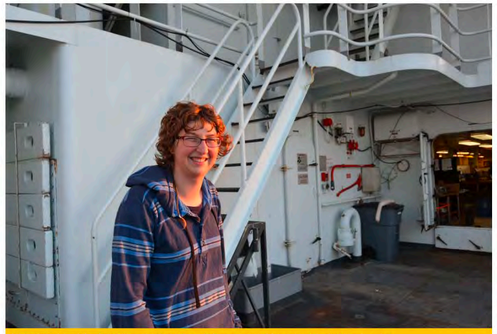
Ship transited ~ 1755 miles!

Regional Cabled Array Training Next Generation Chief Sci's**

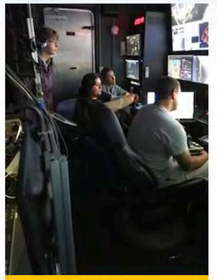
- Leg 1 Chief Sci: Mike Vardaro, Co-Chiefs: Wendi Ruef,** James Tilley
- Leg 2 Chief Sci: Orest Kawka, Co-Chiefs: Mike Vardaro, James Tilley
- Leg 3 Chief Sci: Orest Kawka, Co-Chief: James Tilley
- Leg 4 Chief Sci: Orest Kawka, Co-Chief: Katie Bigham**

Katie Bigham: From VISIONS Student to Co-Chief Scientist

Katie Bigham feels like her journey with the Ocean Observatories Initiative (OOI) has come full circle. She first visited Axial Seamount as a University of Washington (UW) School of Oceanography undergraduate participant on the Regional Cabled Array (RCA) **VISIONS 2014** program when the underwater observatory was being installed. This summer, she returned to Axial Seamount on her seventh cruise, this time as a Co-Chief Scientist.



Katie Bigham on the R/V *Thomas G. Thompson*. Credit: L. Kowalski, University of Washington, V15.



Katie Gonzalez (middle) in the hot seat with Co-Chief Scientist Katie Bigham (left) observing. Credit: J. Nelson, University of Washington, V21.

Katie Bigham (right) and Jesse Turner looking at Neptunea egg cases collected at Southern Hydrate Ridge. Credit: M. Elend, University of Washington, V15.

Katie was excited to step into the role of Co-Chief Scientist on the fourth leg of the annual RCA operations and maintenance cruise (**VISIONS'21**). She previously participated in many other roles on the ship and was looking forward to a new challenge sailing as a Chief Scientist aboard a global class research ship.

oceanobservatories.org Oct 4, 2021

- Katie sailed as an School of O undergrad on VISIONS'14 (84 day installation cruise)
- Upon graduation worked as a Research Scientist for RCA for 2 years
- Now at U. Wellington for Ph.D.

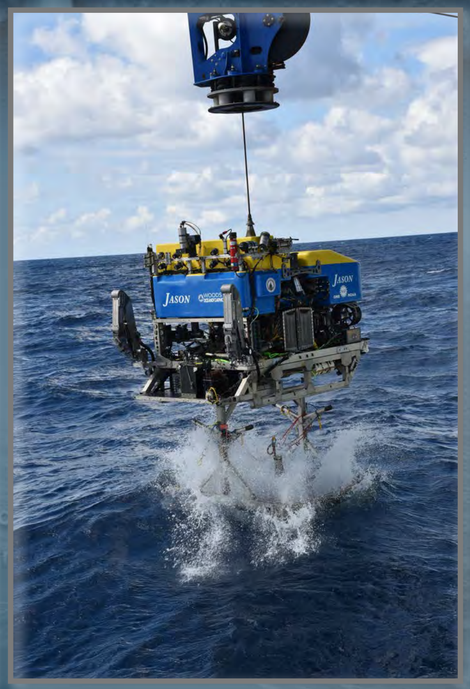
Highly Complex Logistics

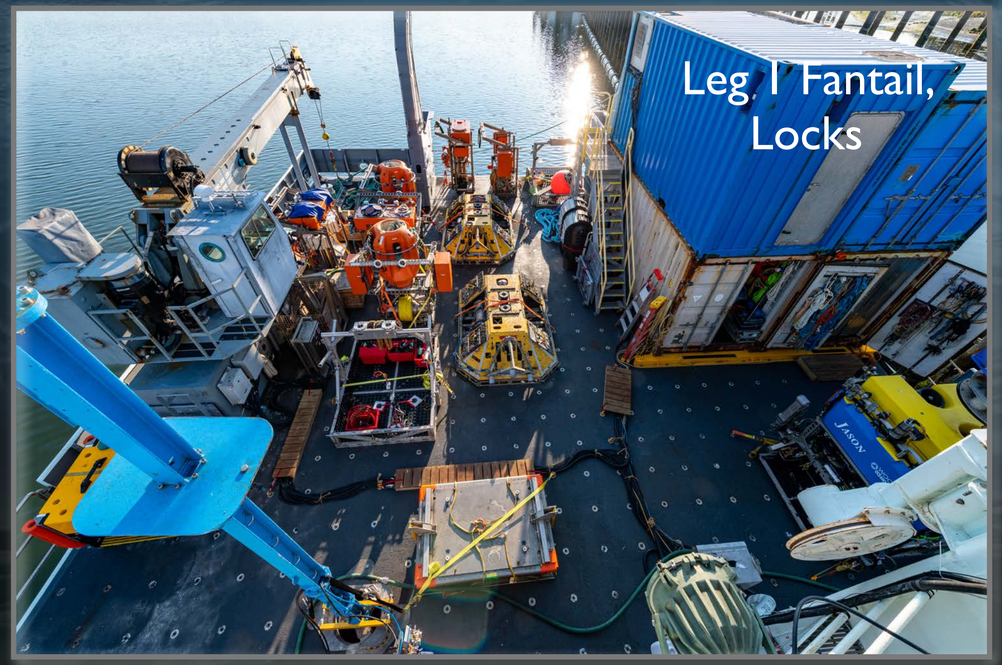
R/V Thompson

Cabled Repair Ship C/S Integrity

Ocean Exploration Trust ET Nautilus

- Three ship operation
- Organizing staffing, shelter-in-place, COVID Tests, full verification of vaccinations, berthing
  - 21 RCA Scientists & Engineers
  - 13 Jason ROV Crew
  - 16 undergrads participated in VISIONS at-sea experiential learning program, 1 postdoc, 1 artist, and 2 research scientists
- 20 48-ft trailers transported 394,000 labs of gear
- Legs 1 & 2 required tight coupling of *Thompson* and *Integrity, shore cranes and trucks (both ships in Newport)*

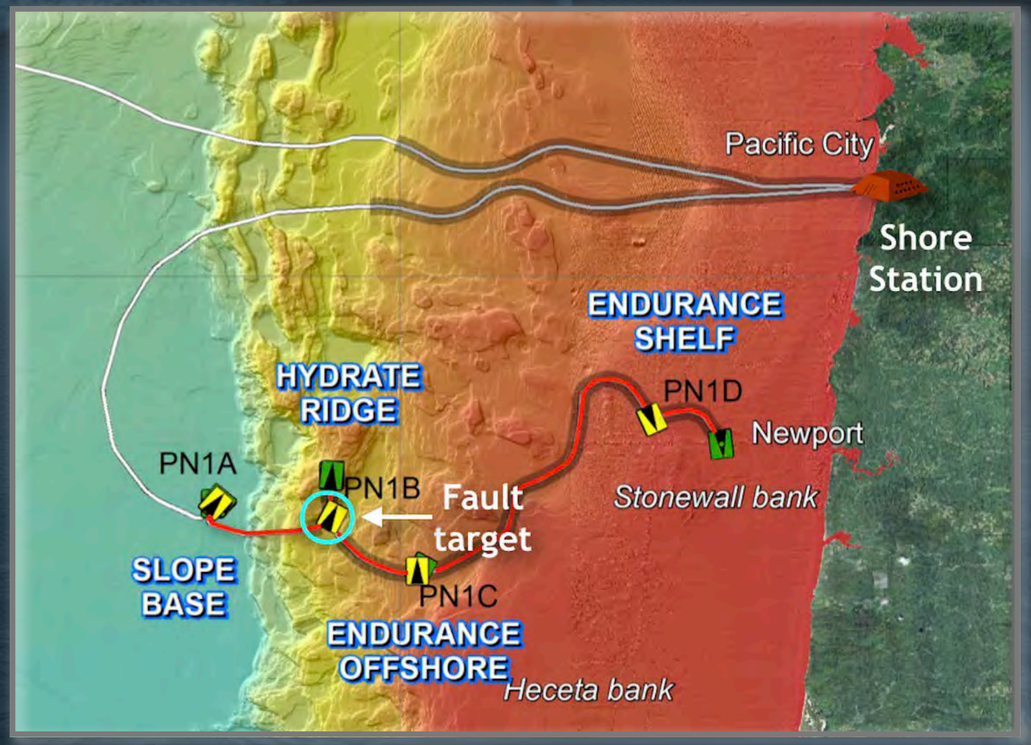




During 30 at-sea days, ALL goals were completed and more

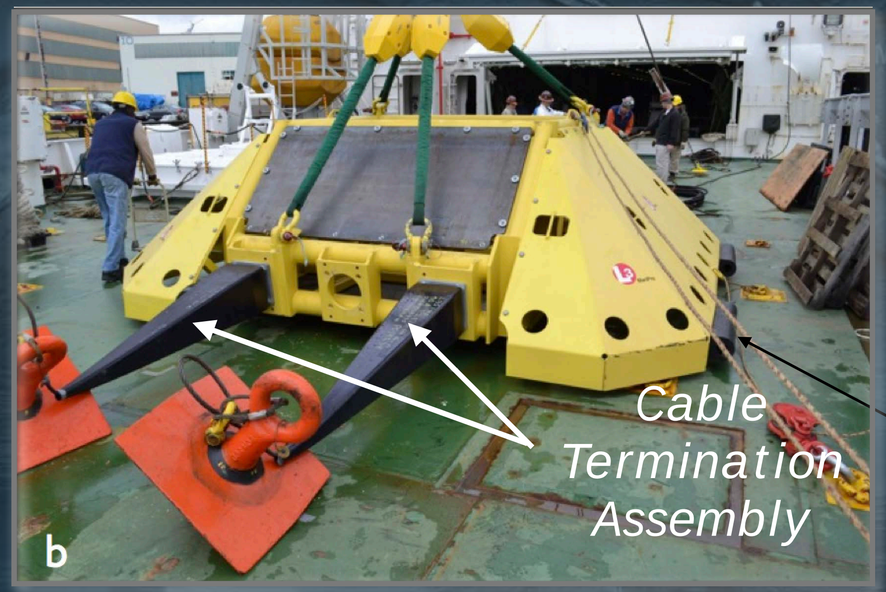
- 49 Jason Dives (J2-1338 to J2-1387)
- Jason traversed a total of ~ 125,000 meters of the water column
- Over 200 RCA instruments recovered-installed
- Time-series EM302 bubble plume surveys of SHR imaged methane seep activity
- A new vigorous methane seep site discovered
- Pythias Oasis (Kelley-NSF) continuously venting since 2014 - unlike any seep in the world's oceans
- Three CTD's now installed in Axial Caldera - awaiting next eruption and documentation of brines emitted from the seafloor (Chadwick - NSF)
- Three BOEM dives at ASHES for fluid, rock, microbiology in support of NASA effort (Kelley)

PN1B Failure



In August 2020, Primary Node PN1B failed, shutting down south line east of Slope Base

Believed fault was in backbone interface assembly (BIA) - hard wired to primary cable



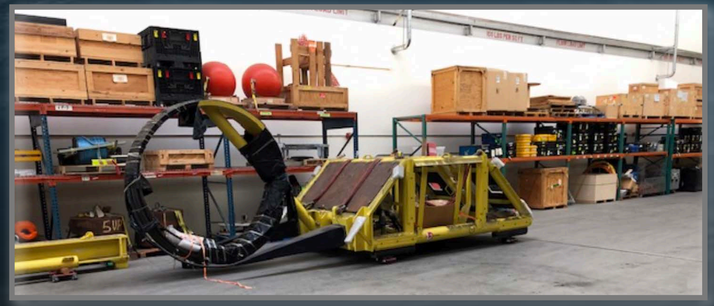
Primary Nodes are Big "Beasts"
14,000 lbs, 18' long, 16 ft wide

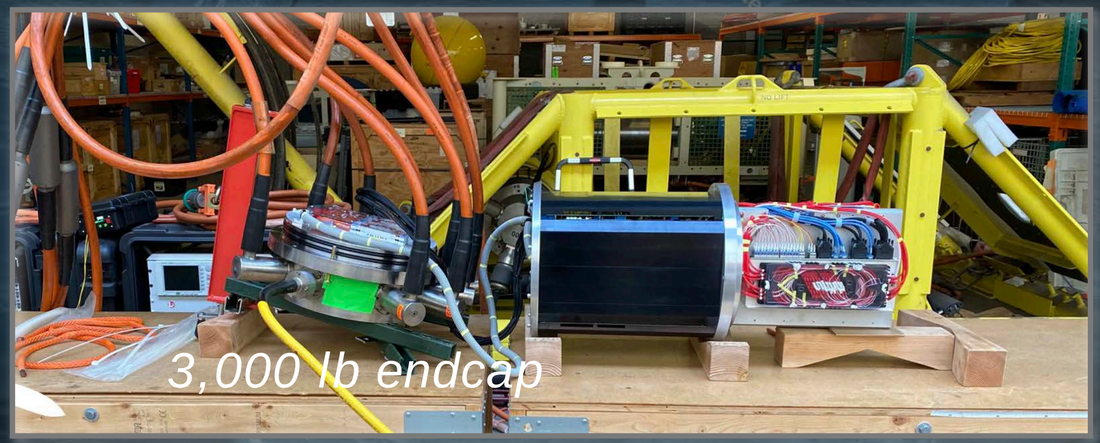
- *Nodes Contain a Backbone Interface Assembly (BIA) - conver 10,000 v to 375 v; hardwired to Primary Backbone cable*
- *Science Interface Assembly (SIA): Provides power and communication to Secondary Infrastructure; removable via an ROV*

PN1B Replacement and Testing

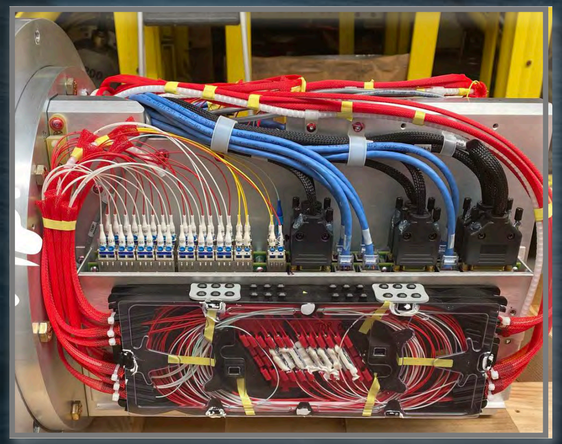
RCA - Sandpoint

Primary Node Testing Equipment





SIA opened up

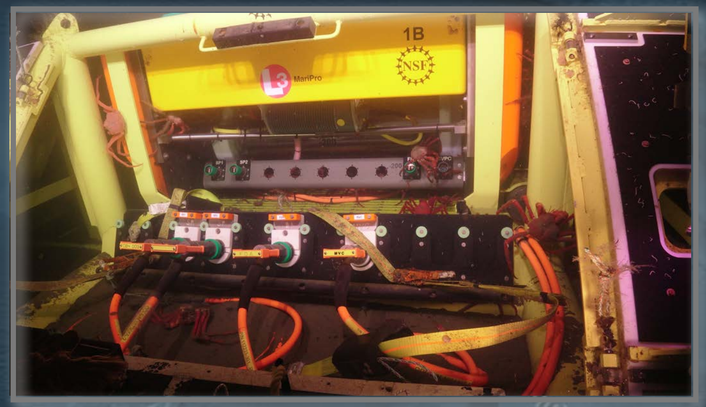


Fiber Distribution Assembly

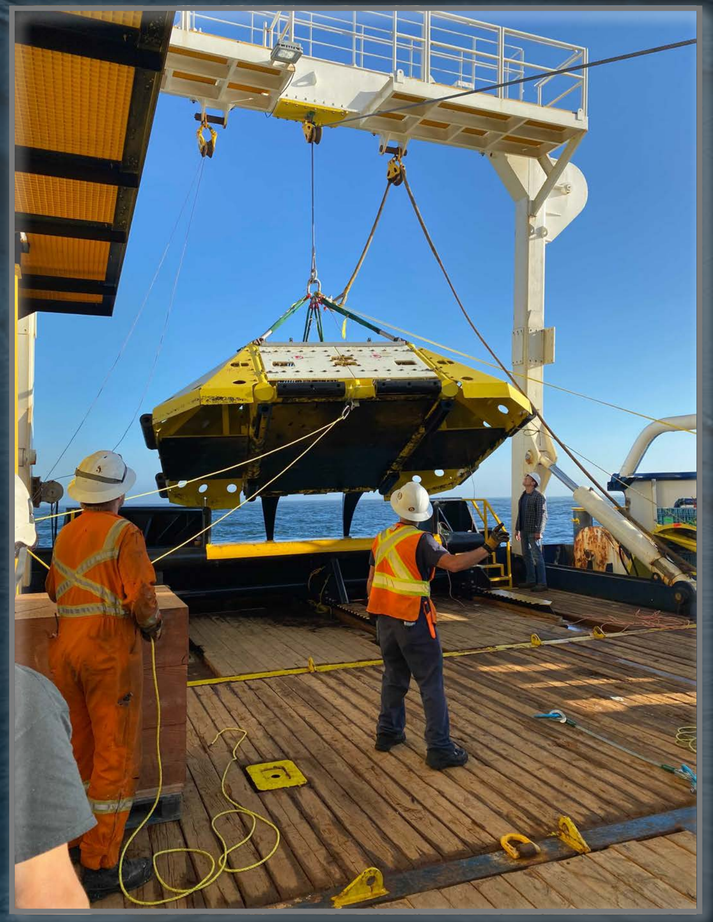
- RCA took on all responsibility - Cable Repair Ship and Testing of Node
- Spare node brought up from Swan Island Depot, OR
- All components tested: Chuck McGuire & Larry Nielson
- RCA now in-house expertise - free from industry

Recovery of PN1B

Replacement Primary Node
on way to Newport

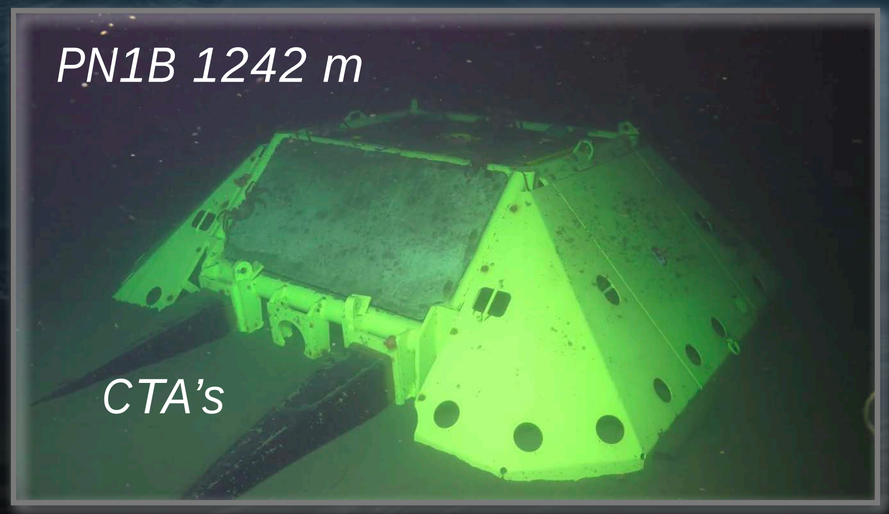


Unplugging SIA and Cable to
SHR Crab house



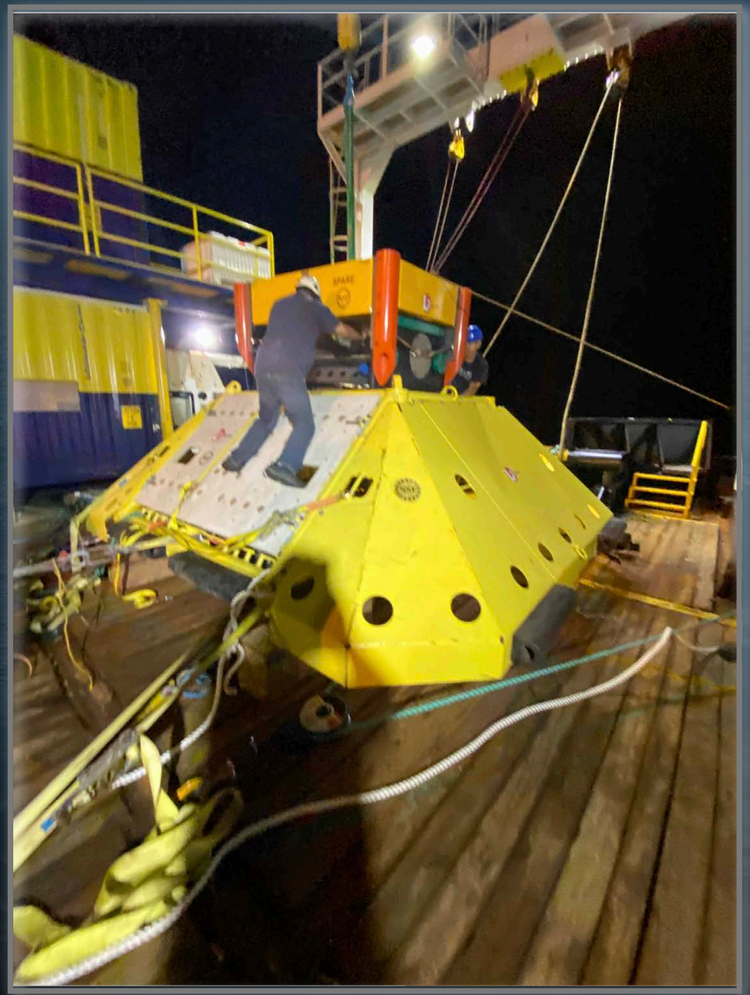
Primary Node brought onboard
the C/S Integrity

Science Interface Assembly
Recovered onto the TGT



Inspection by Jason

PN1B Failed Deployment & RCA Solution



Replacement Primary Node
Readied for Installation

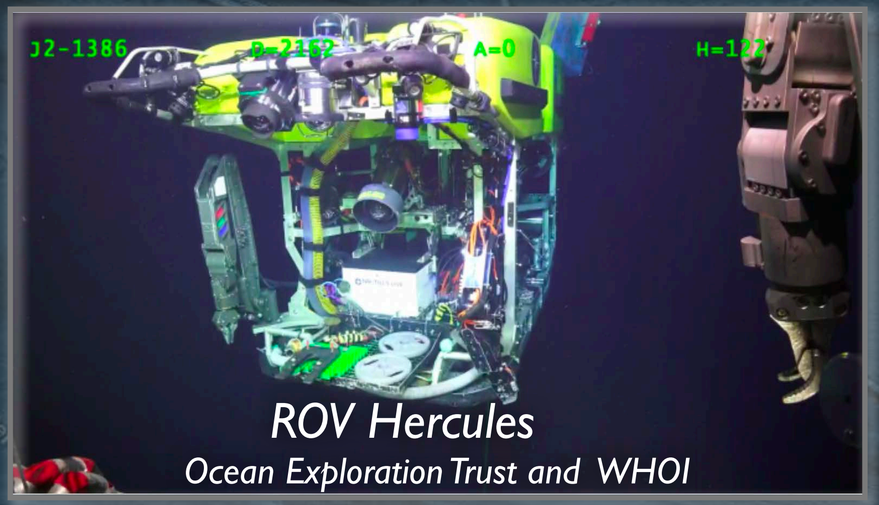
During lifting off deck, node slipped and CTA likely damaged

Solution was to splice the two backbone cables together, bypassing the Primary Node

C/S Intrepid 377 ft in length;
Reinstallation for June

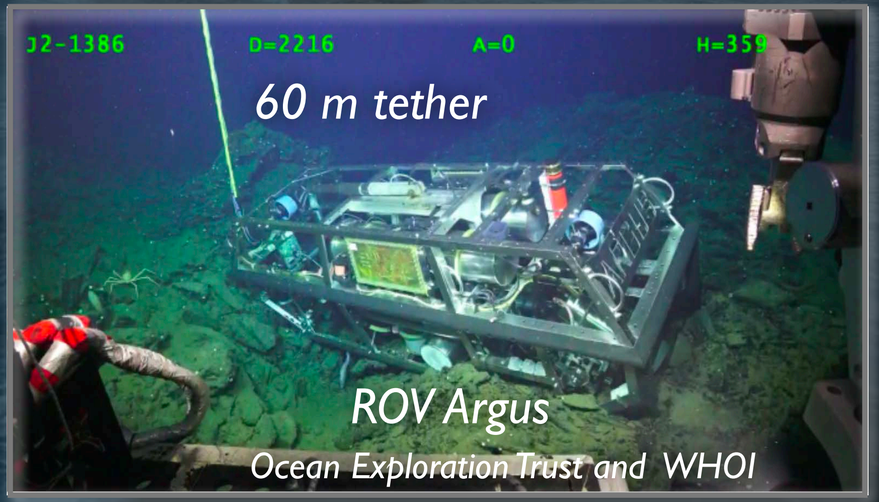
- Result - all of Oregon Offshore and Shelf Operational - brought 83% of instrumentation online: SHR offline
- UW Secured C/S Intrepid for Node Reinstallation 2022
- RCA conducting testing-repair of both nodes - having to make our own specialized tools MVC test next week

August 26 - Called to Rescue 2 Remotely Operated Vehicles



R/V Thompson steamed 10 hrs north and Jason dove to 2200 m to aide in the recovery of Ocean Exploration Trust two ROV's Hercules and Argus

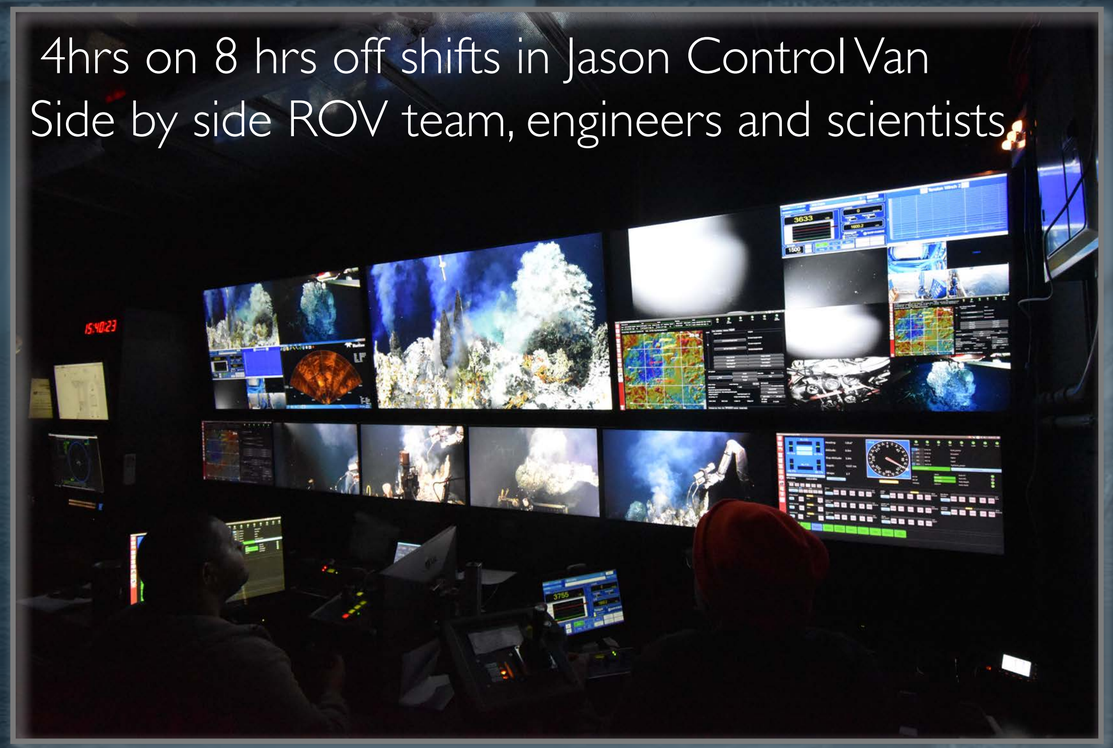
Both recovered Sept 2!!



Two ship Operation

OE Chief Sci: Allison Fundis
Prior RCA EPE Lead OOI -1.0

VISIONS'21
Students at Sea



- 16 undergraduates
- 2 Research Scientists
- 1 Postdoc

Learned Instrumentation
Data collection for projects

Ultimate Biofouling

Sample Processing

Analytical methods

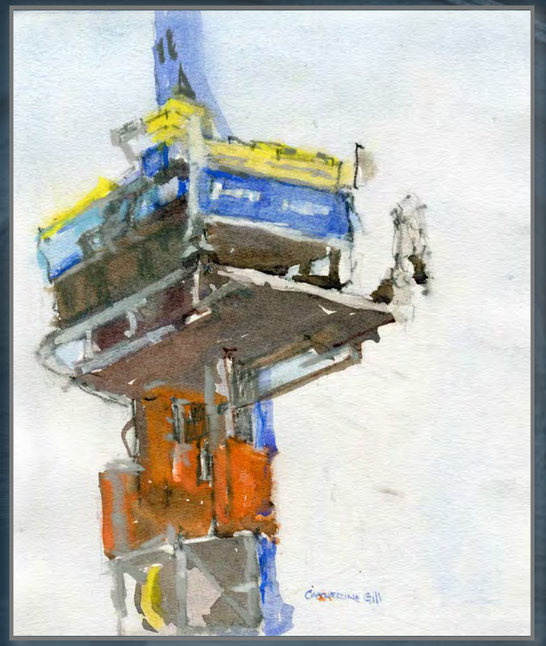
VISIONS'21 Student Projects

Genevieve Kent: VISIONs'21 Leg 1
UW Marine Biology Undergrad
Tubeworms with symbiotic bacteria

Ridgeia Tuberworms (*Ridgeia piscesae*)

- Continuing to Grow Interactiveoceans biological catalogue
- AI dectection of thin layers
- AI detection - identification of animals

The Sea Viewed Through an Artists Eyes



Cathe Gill: VISIONS21 Legs 3&4

NW watercolor artist

Katie Gonzalez Senior Thesis

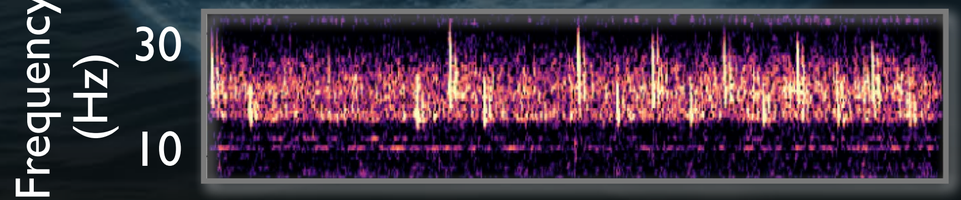
"Seasonal Patterns of Fin Whale Calls in the NE Pacific"

VISIONS'17-21 Student, Now RCA staff

- First study of Fin whale location preference in the NE Pacific
- Utilized 5 years of RCA low-frequency hydrophone and seismometer data from Slope Base and Axial Base
- Automated detection algorithm of 143,102 calls

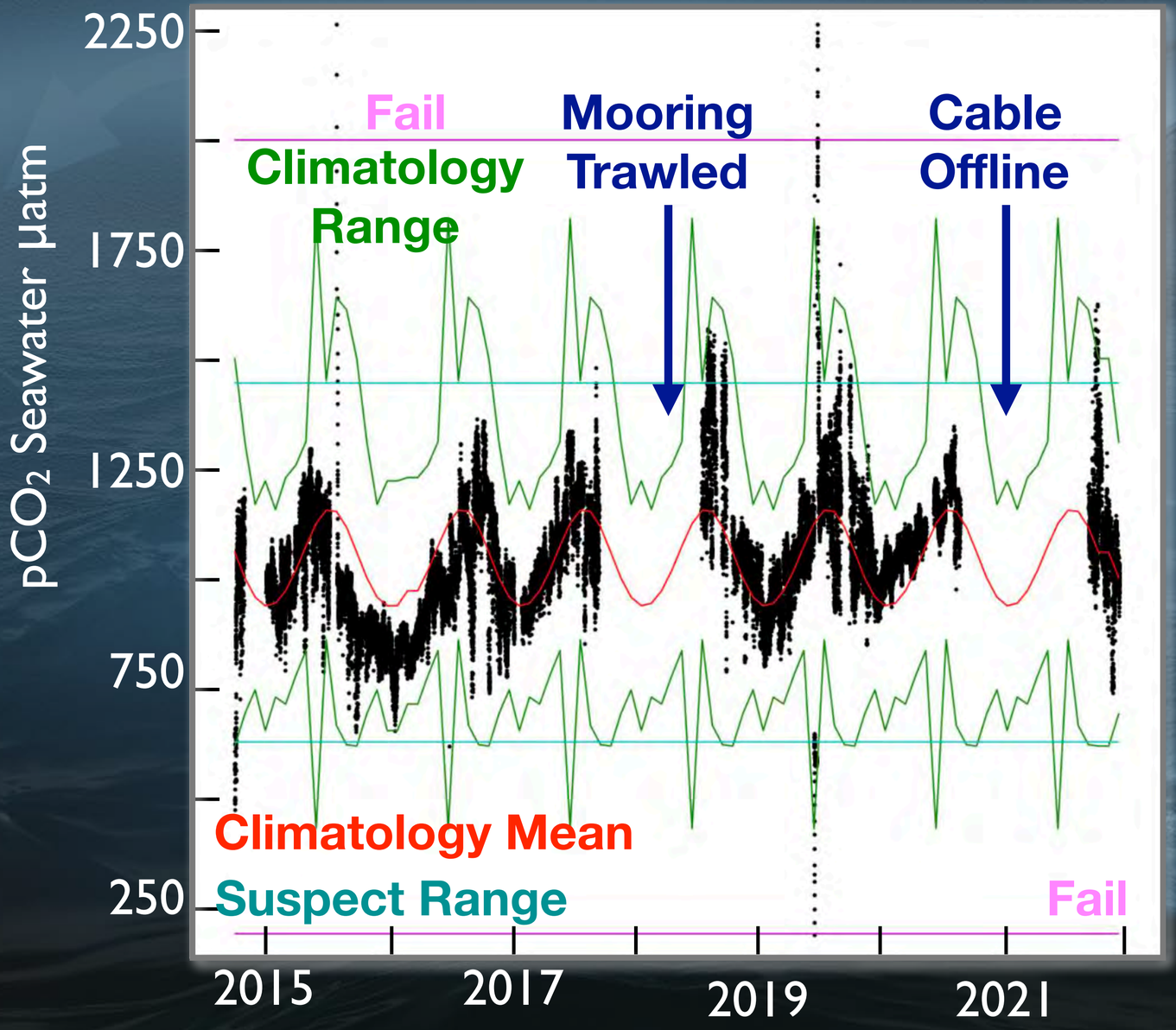
Fin whale calls appear seasonal - appear 2-3 months earlier at Slope Base and in greater magnitude than at Axial Base 300 km to the west

Congregate in productive coastal waters, then disperse offshore later in season in search of food or for breeding



Oceanobservatories.org "Kathleen Gonzalez: Student Ambassador for VISIONS'21 Expedition"

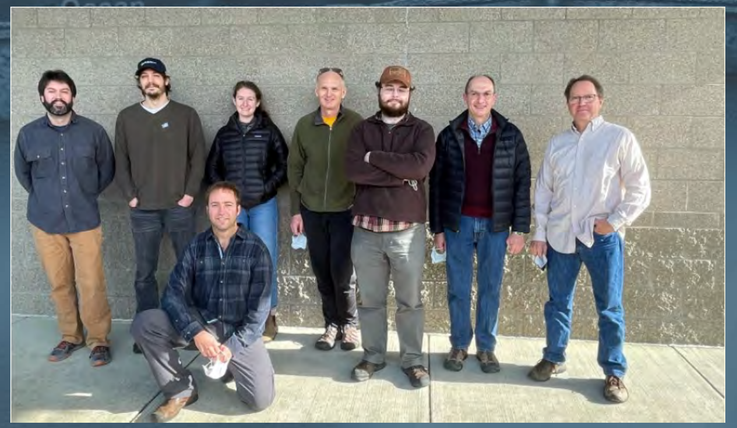
Data QA/QC



Significant progress in pCO2 and pH QA/QC
C. Wingard and W. Ruef collaboration
Cross MIO Python Script for consistent evaluation

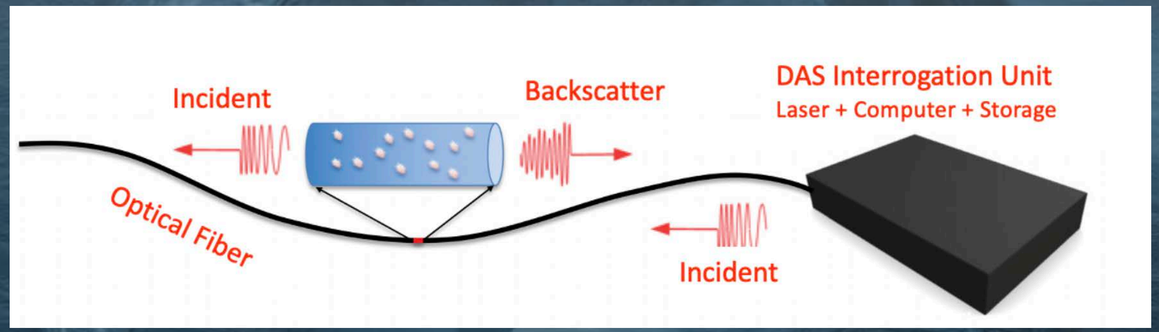
- solid time-series, over 99% of the data points passed the current (QARTOD) and enhanced QC filters
- 65% data coverage of expected time series, with the trawl event and cable outage as big factors
- enough good data points to calculate a representative climatology
- Next step - comparing "nearest neighbor" data - e.g. Newport Line

One of many success stories to present to users!



Highlights of A Few New NSF Award ($3,152,248 not including ship-ROV time)*

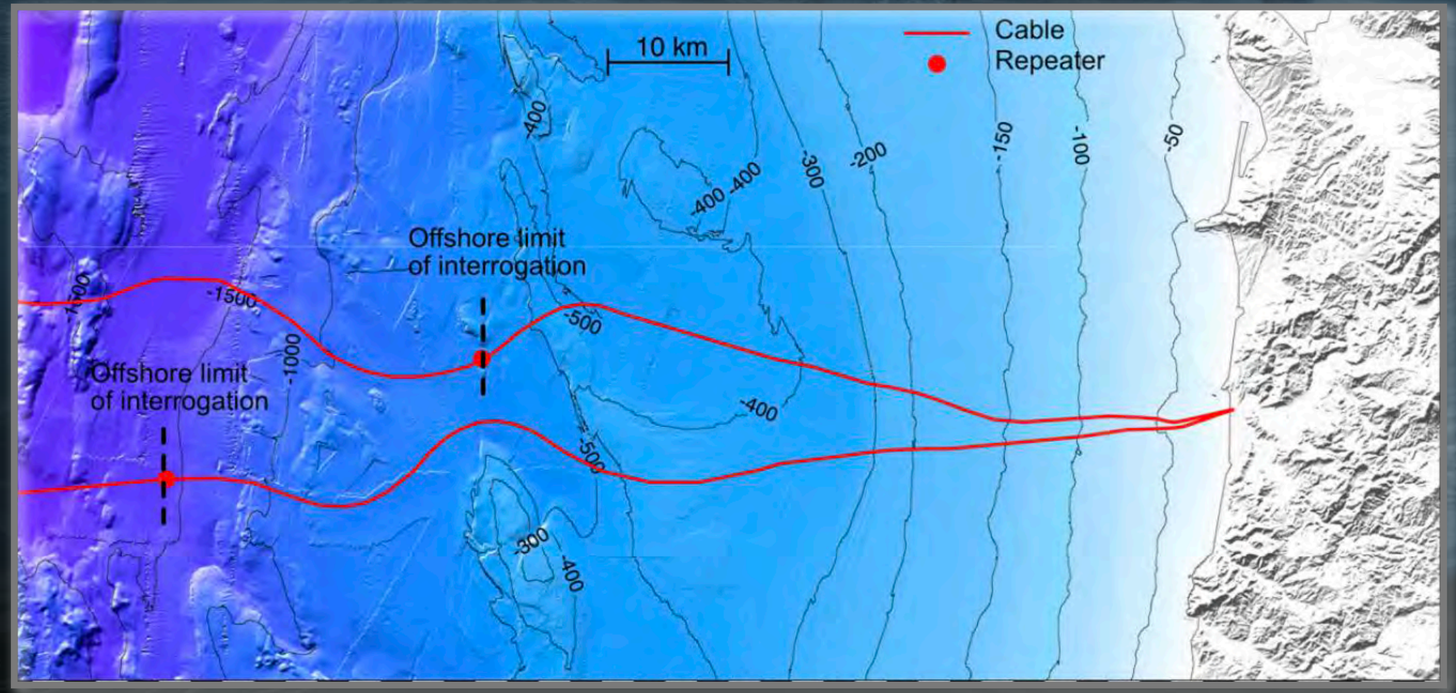
William Wilcock (2141047 OCE-MGG) RAPID: A community test of Distributed Acoustic Sensing on the Ocean Observatories Initative Regional Cabled Array($132,500)



- Distributed acoustic sensing (DAS) new technique - interrogates an optical fiber with repeated laser pulses and utilizes changes in the phase of backscattered light to measure the strain rate along the fiber. Currently requires a dark fiber.
- The method can work to distances of up to ~100 km and has a spatial resolution of a few meters and a broad frequency sensitivity.
- A DAS fiber optic cable behaves similarly to a long line of closely spaced single-axis broadband seismometers. Considerable interest because of the potential of submarine DAS to observe seismic, oceanographic, acoustic and geodetic processes.

Courtesy: W. Wilcock

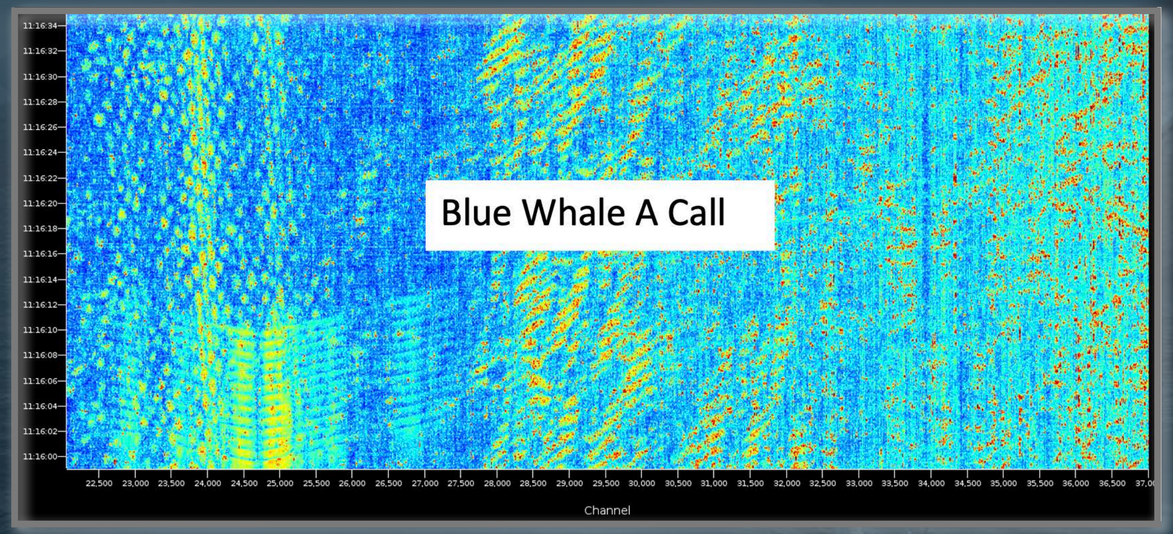
- November 1-5, 2021 - DAS Data Acquisition
- Silixa iDASv3 distributed acoustic sensor; Silixa ULTIMA SM distributed temperature sensor systems; Two OptaSense QuantX systems
- Currently undergoing Navy Review - up to 90 days; winter or spring released to the public through UW-RCA: Distributed on hard drives.



Courtesy: W. Wilcock

A few data snippets were screened and release to vendors and a few screen shots of interesting signals released

OptaSense Waterfall Plots 15-25 Hz



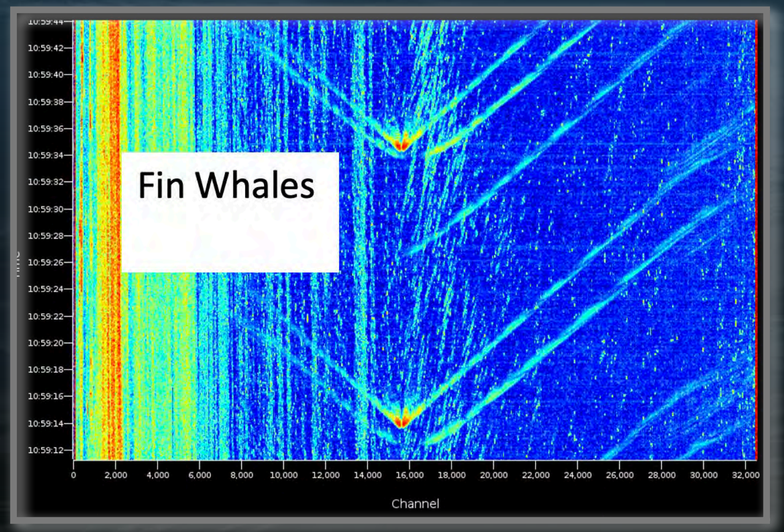
Time 30 s

45 km

70 km

Potential Science

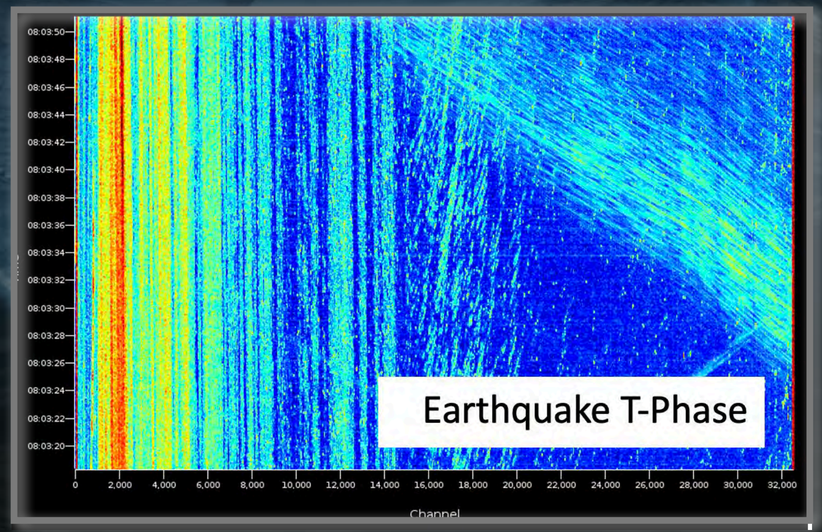
- Shallow Structure and Faults
- Ocean wave spectra, compliance and currents
- Earthquake signals, including T phases
- Infragravity waves and internal tides
- Whales
- Ship noise



Time 30 s

0 km

60 km

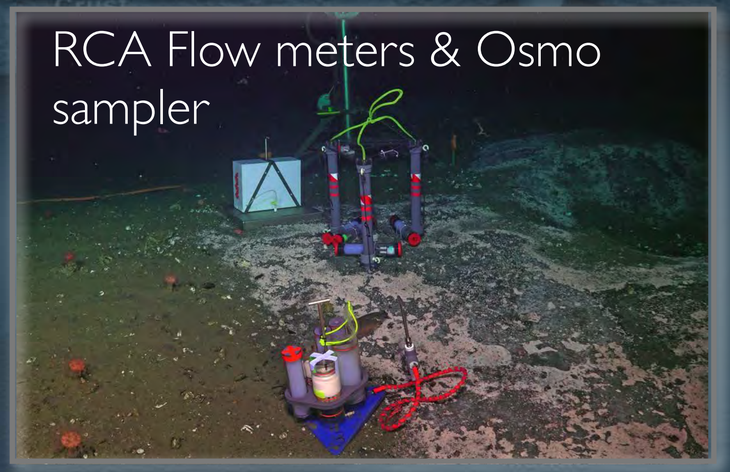


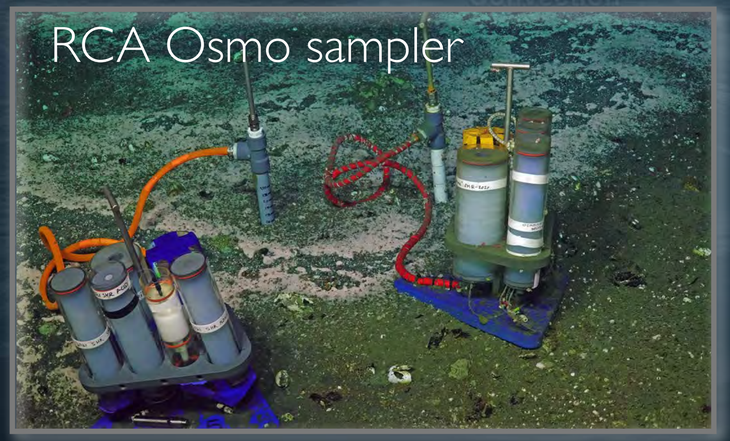
Time 30 s

0 km

60 km

Courtesy: W. Wilcock





Laura Lapham, University of Maryland (2049517-Chem) Collaborative Research: Investigating the source and flux of dissolved organic carbon released from methane seeps to the deep-ocean. $1,134,372 2 days at-sea

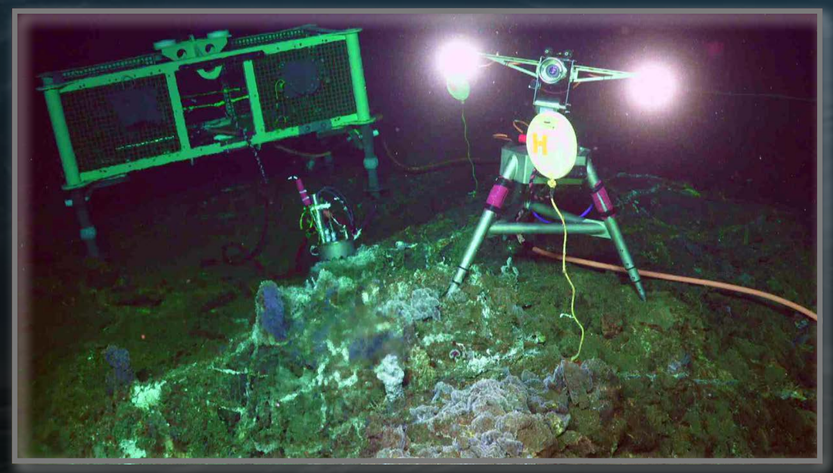
- How much CH4-derived fossil DOC do seeps contribute to the ocean?
- To what extent is CH4-derived C incorporated into DOC during aerobic oxidation of CH4?
- Is seep DOC bioavailable or recalcitrant when released into the deep ocean ★
- How does the flux of DOC to the water column vary over time?

Will install osmotic fluid samplers and collect push cores at Hydrate Ridge, coupled with RCA environmental data and time-series.

Field program delayed a year, has asked to join RCA 2022 cruise for resampling

Rika Anderson Carleton Colllege (OCE2045697 - Bio) CAREER: Temporal dynamics of microbial and viral function and adaptation in hydrothermal vents ($593,722) 5 years, 6 days at sea. Utilize RCA fluid-microbial DNA data, and other sensor data in the Axial International District and collect additional samples. *Extra funding to do high end sequencing on RCA PPS samples.

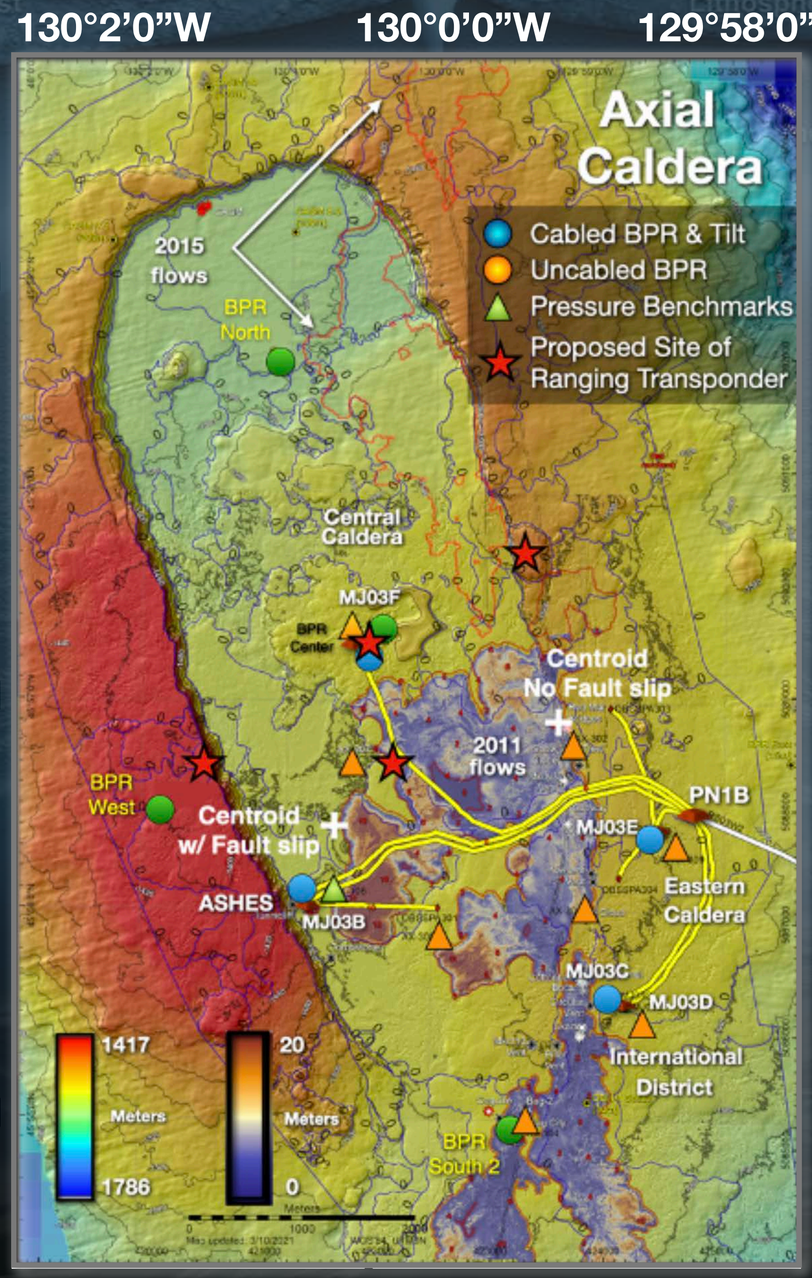
- Rich time-series of microbial and viral metagenomics every 10-20 days for 3 years
- Increase understanding of microbial function in subsurface habitats in response to perturbations - help constrain marine biogeochemical cycles
- New insights into marine viral ecology in habitats outside commonly studied surface oceans
- Shed light on evolutionary processes most ancient habitats on Earth
- Generate rich dataset that can be used by others to investigate future questions.



Camera, RAS-PPS, 3 temperatures

Vent cap with inlets to RAS-PPS

Tiny Towers Community

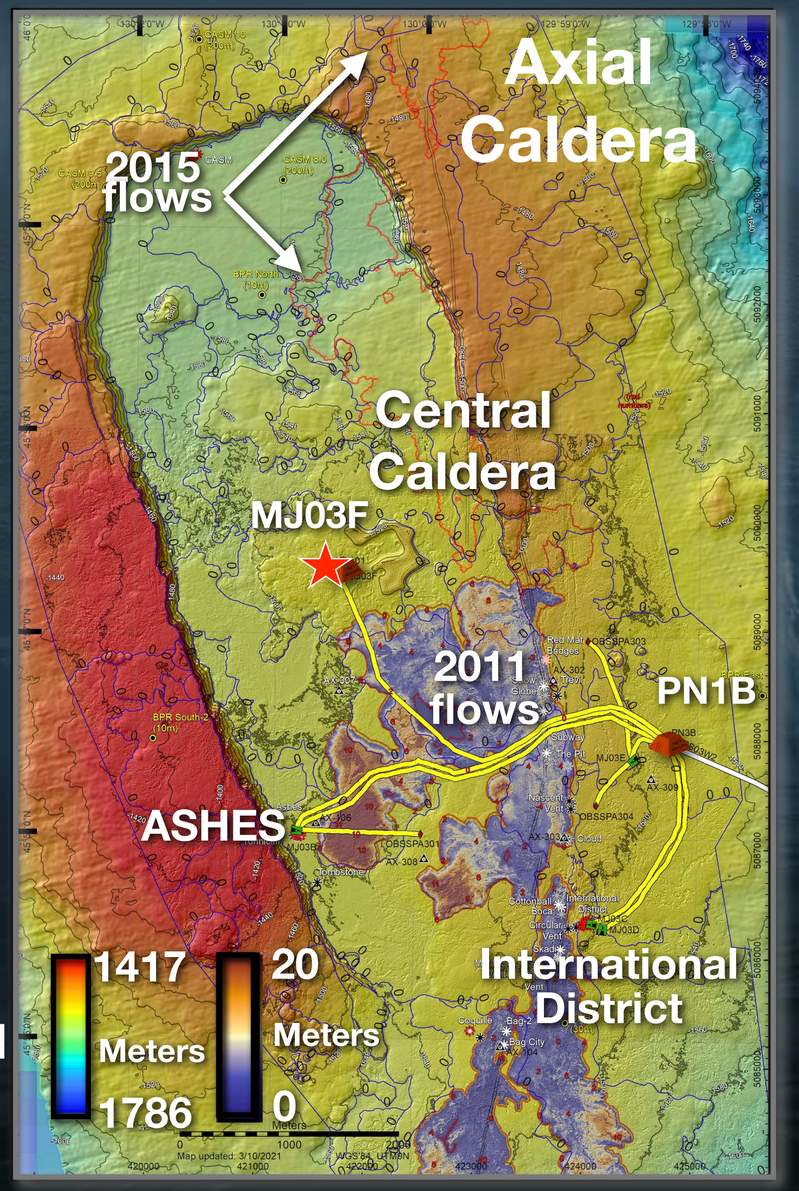


★ Acoustic Ranging Transponders

William Wilcock and Dana Manalang (OCE-MGG) "An Acoustic Array at Axial Seamount for Geodesy and Autonomous Vehicle Support" 4 days at-sea. Propose 10-year experiment ($867,100)

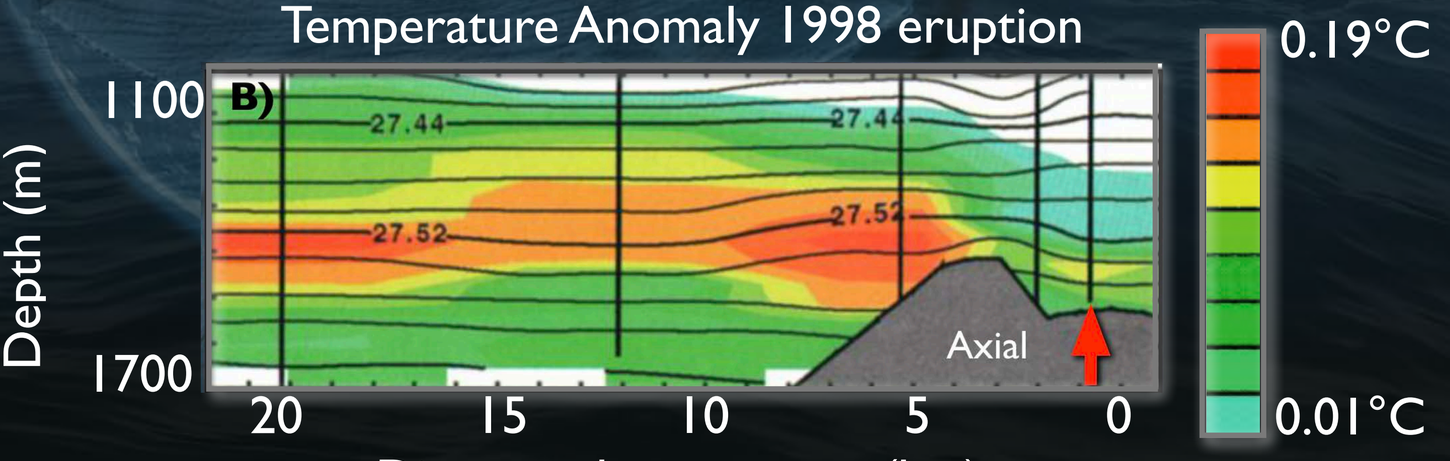
- Monitor horizontal strain along baselines that connect 4 acoustic transponders. ★
- Central Caldera: First in-cable pressure transducer connected to a transponder for real-time data, transceiver command functionality to uncabled transponders
- Movement of buried outward dipping faults during the volcanic cycle.
- Rates of fault slip associated with increase in seismicity during inflation
- Precise navigation for AUV's - are in conversation with D. Caress (MBARI) for collaborative effort with their AUV.

D. Manalang and D. Kelley (OCE 2129943 -OTIC) RAPID: OOI-Industry Partnership to Install a Cabled 45 kHz ADCP at Axial Seamount Caldera ($20,692)

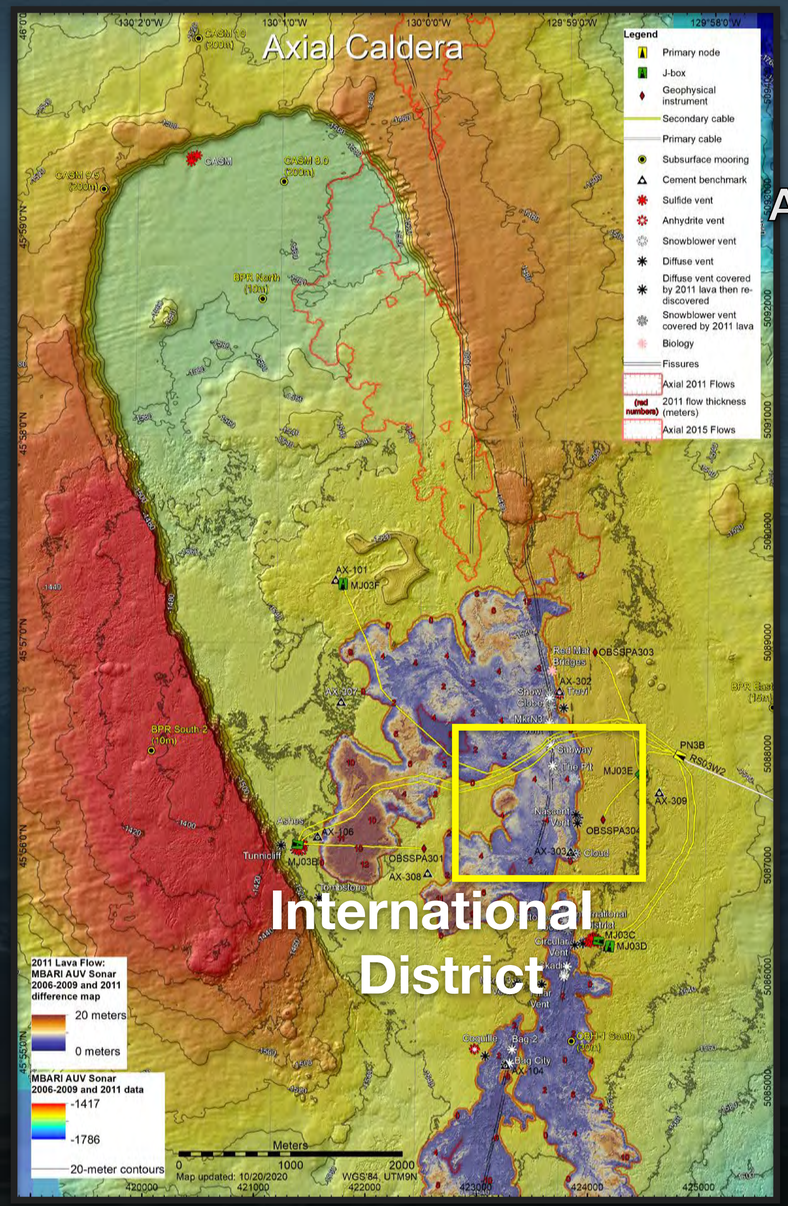


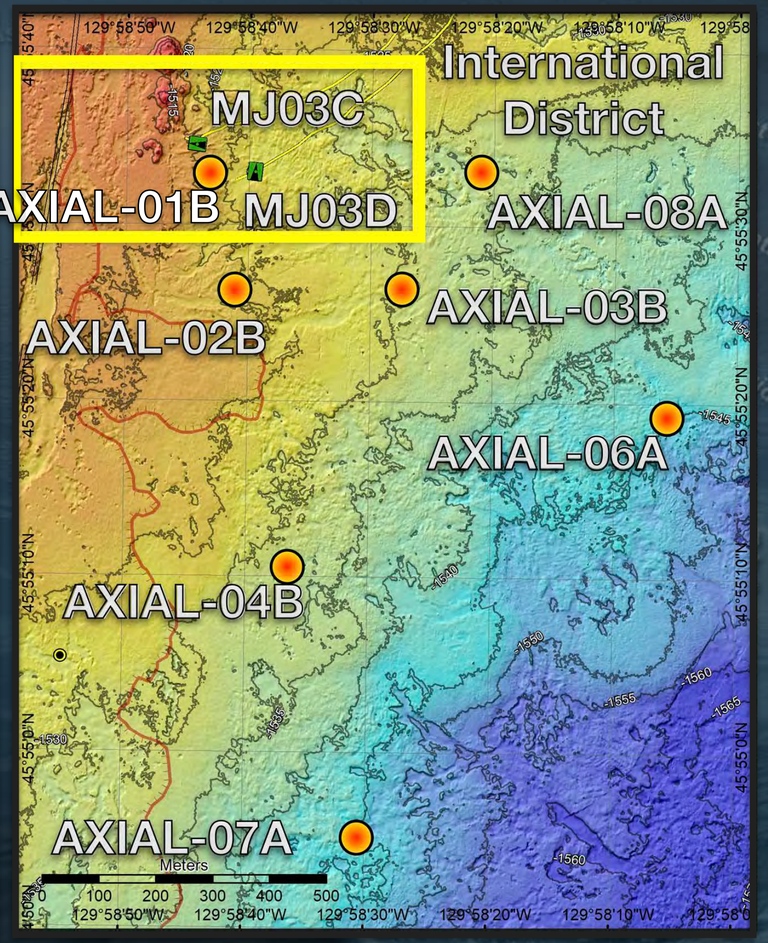
- Partnership with Teledyne Marine to test a 45kHz Pinnacle ADCP designed to image the entire 1500 m of water column. Installed this year at Central Caldera. MJ03F will be turned in ~ 5 years - continuous current measurements.

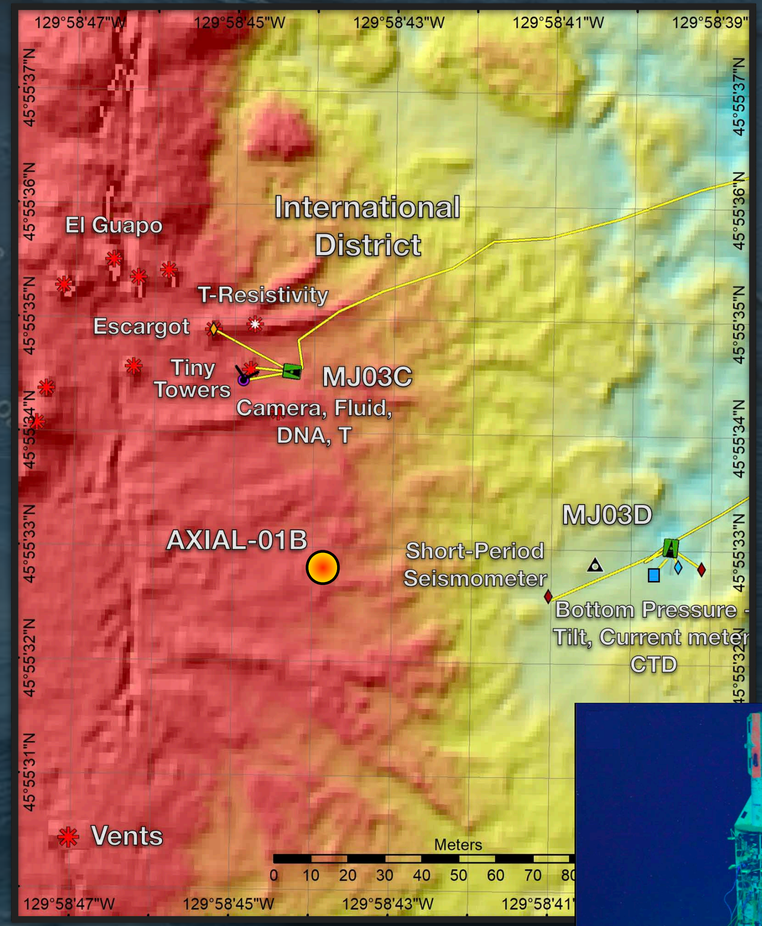
- Would allow the first real-time imaging of megaplume formation in the oceans. Rise >1000 m into the water 20 km across, inject significant heat, chemicals, volatiles into the overlying ocean. Windows into the deep biosphere.



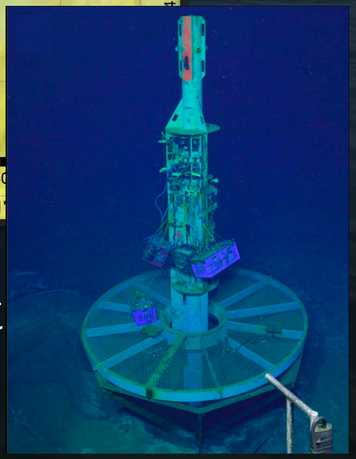
IODP Proposal: "Integrating subseafloor microbial, hydrological, geochemical, and geophysical processes in zero-age, hydrothermally active oceanic crust at Axial Seamount, Juan de Fuca Ridge"







- IODP requested Safety Review - Extensive document (e.g. 144 pages for Brothers Volcano, NZ) - hoping drilled before JOIDES Resolution Goes Away
- Environmental Assessment Submitted to NSF



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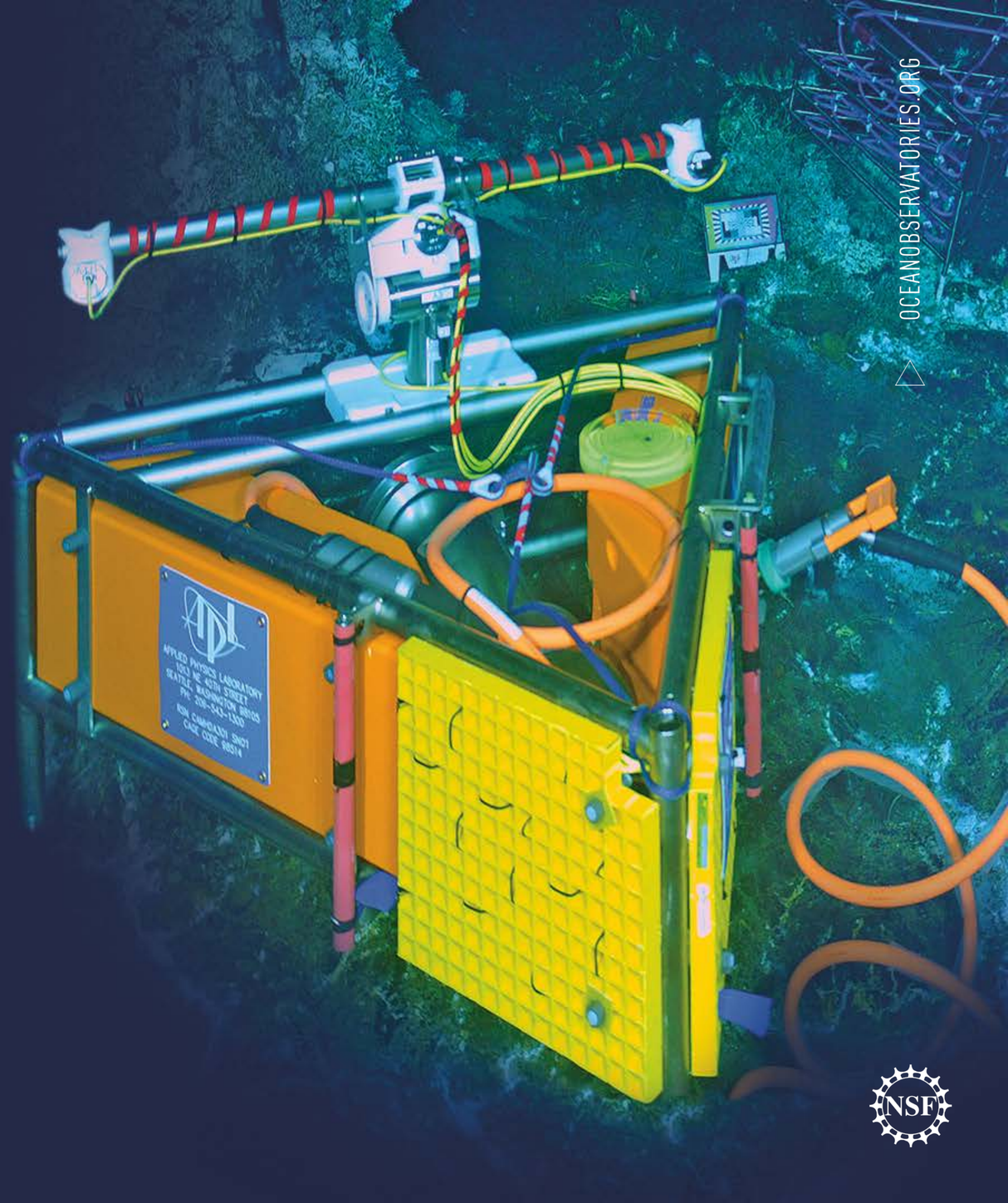
INITIATIVE

Questions?



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