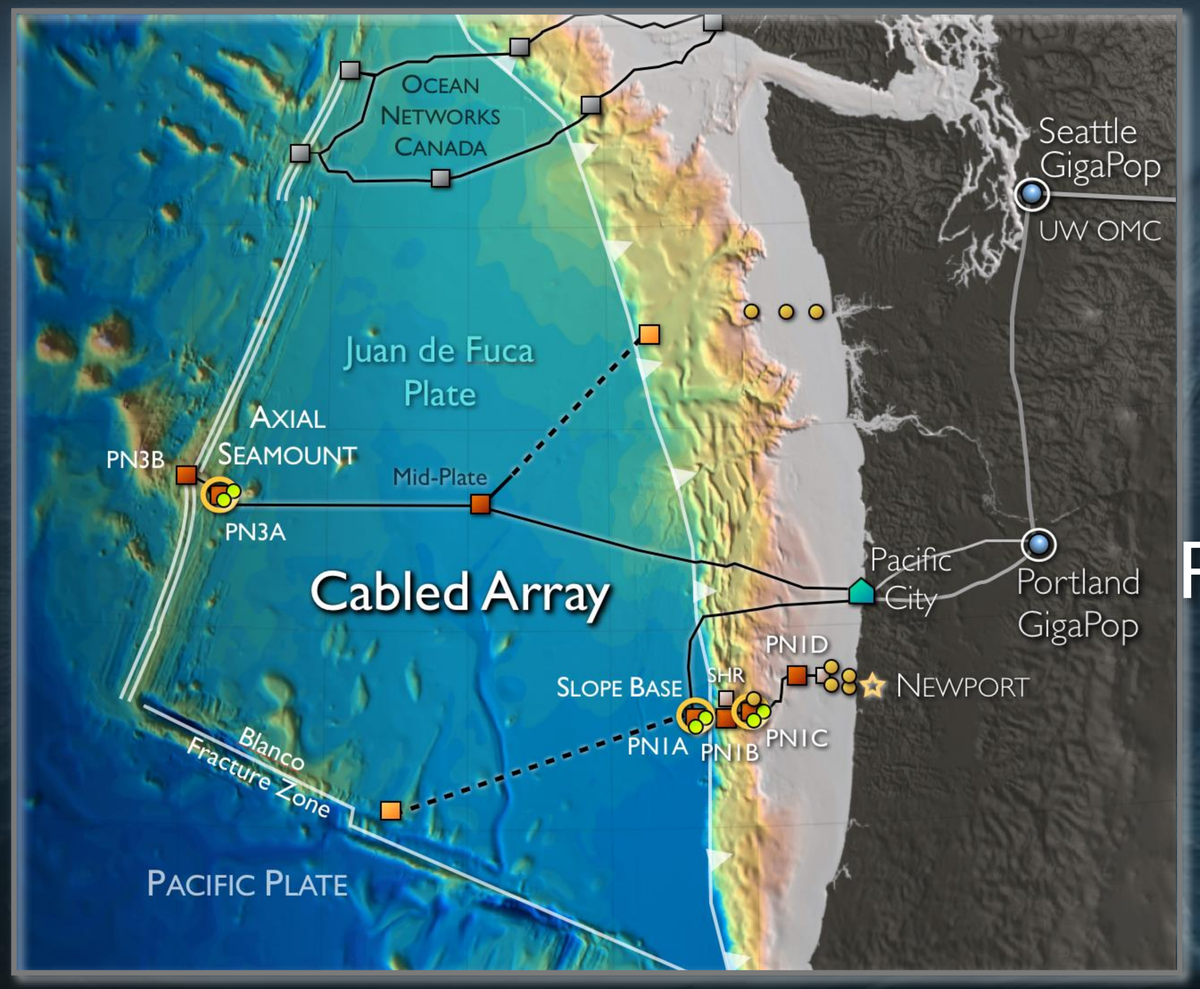
Regional Cabled Array

John Delaney, Deb Kelley
and the Cabled Array Team

AGU DESSC Meeting 2018
University of Washington

Cabled Coastal Array: Why NE Pacific?



Significant expansion capabilities

Some of most productive waters in worlds' oceans, large potential energy reserves - methane ice deposits, wave energy etc

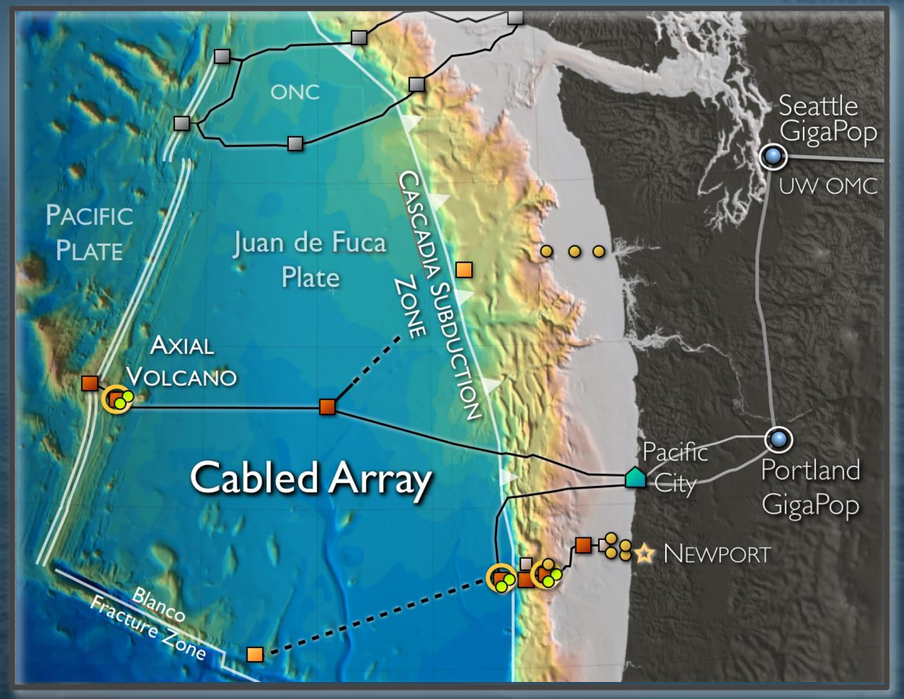
Significant Societal Applications

Real-time monitoring >140 instruments

- Climate Change, Anoxia, Ocean Acidification, Storms, Carbon Cycle
- Offshore seismic activity, tsunami's
- Submarine volcanism and life
- Bioacoustics, mammal tracking

Sail with very full deck loads to optimize at sea time

Regional Cabled Array - Field Operations 2018



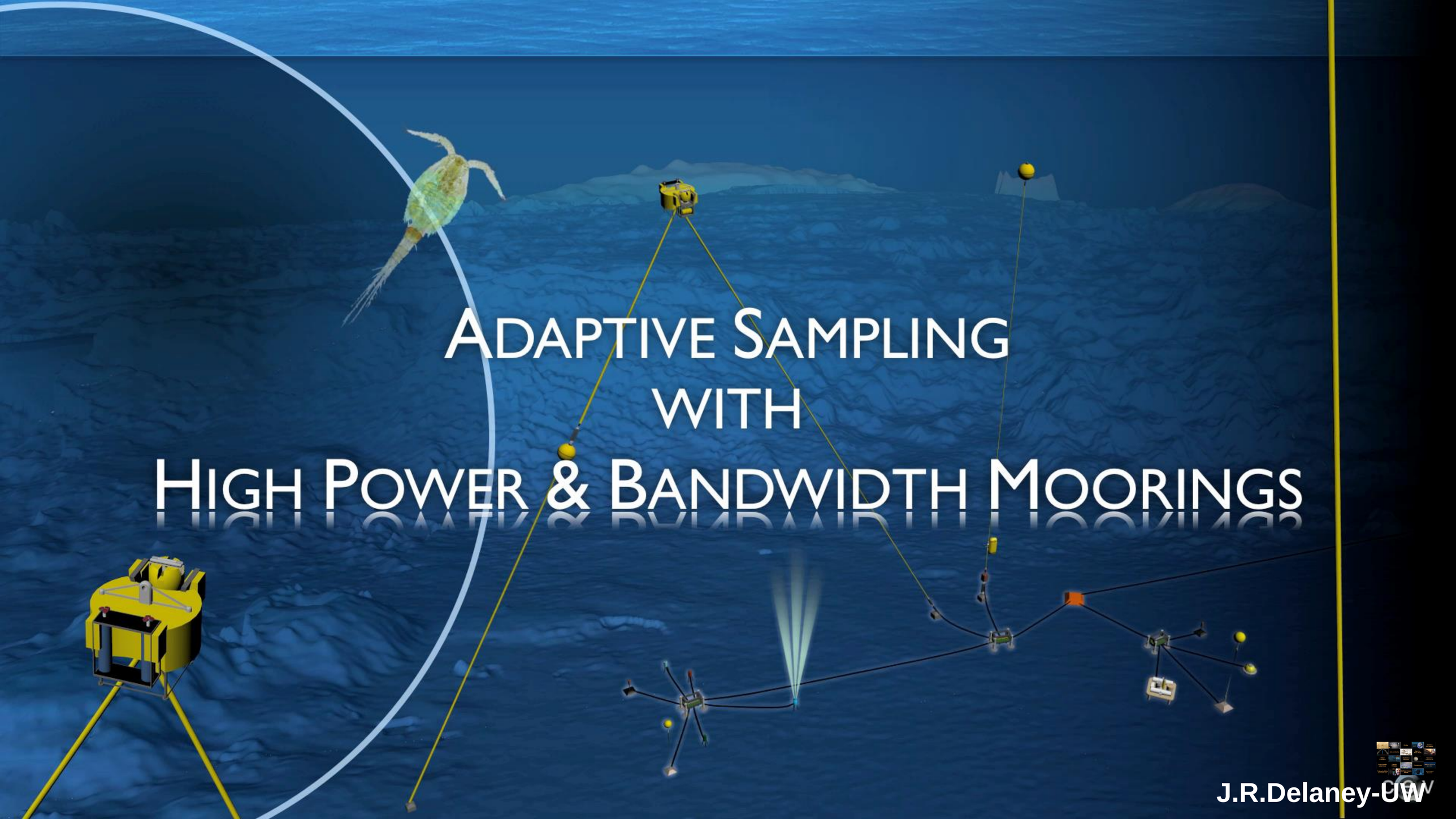
- 4th Operations and Maintenance Cruise 47 days, 4 Legs, 6/19 to 8/5
- R/V Revelle and ROV Jason - 58 dives
  - Turned 5 Junction Boxes
  - 3 Shallow Profiler Platform Assemblies, 3 Shallow Profiler Science Pods (Axial Platforms Recovered)
  - First time reinstallation of complete 2-legged Shallow Profile Mooring - Endurance Offshore
  - 2 Benthic Experiment Platforms
  - 84 CORE instruments turned-installed
  - 11 Installations of new PI instruments/Platforms & Turning of 2
  - 3 Deep Profiler moorings
  - 15 verification CTDs plus Jason Niskins and gas-tights
  - Recovery of *Jason* elevator dropped last year (2 instruments)
- VISIONS '18 - 28 undergraduate and graduate students: UW, Grays Harbor, Queens College NY, Chico - California State
  - USA, Taiwan, Malaysia, Argentina

First installation of 2 legged Shallow Profiler Mooring during O&M

- Supplied with 3 kW power, 1 Gbps communications
- Hosts 18 sensors
- Profiler makes 9 trips/day - first time co-registered measurements 24/7/365 of critical ocean properties
- 2-way, real-time communications allows reactive event sampling - .e.g. response to thin layers, storms, megaplume formation

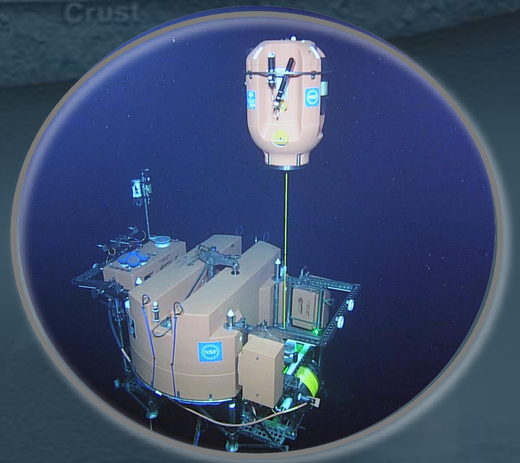
Three profilers have made >30,000 profiles since 2015

Adaptive Sampling with High Power & Bandwidth Moorings



J.R.Delaney-UW

Providing unparalleled “imaging” of shallow oceanographic processes

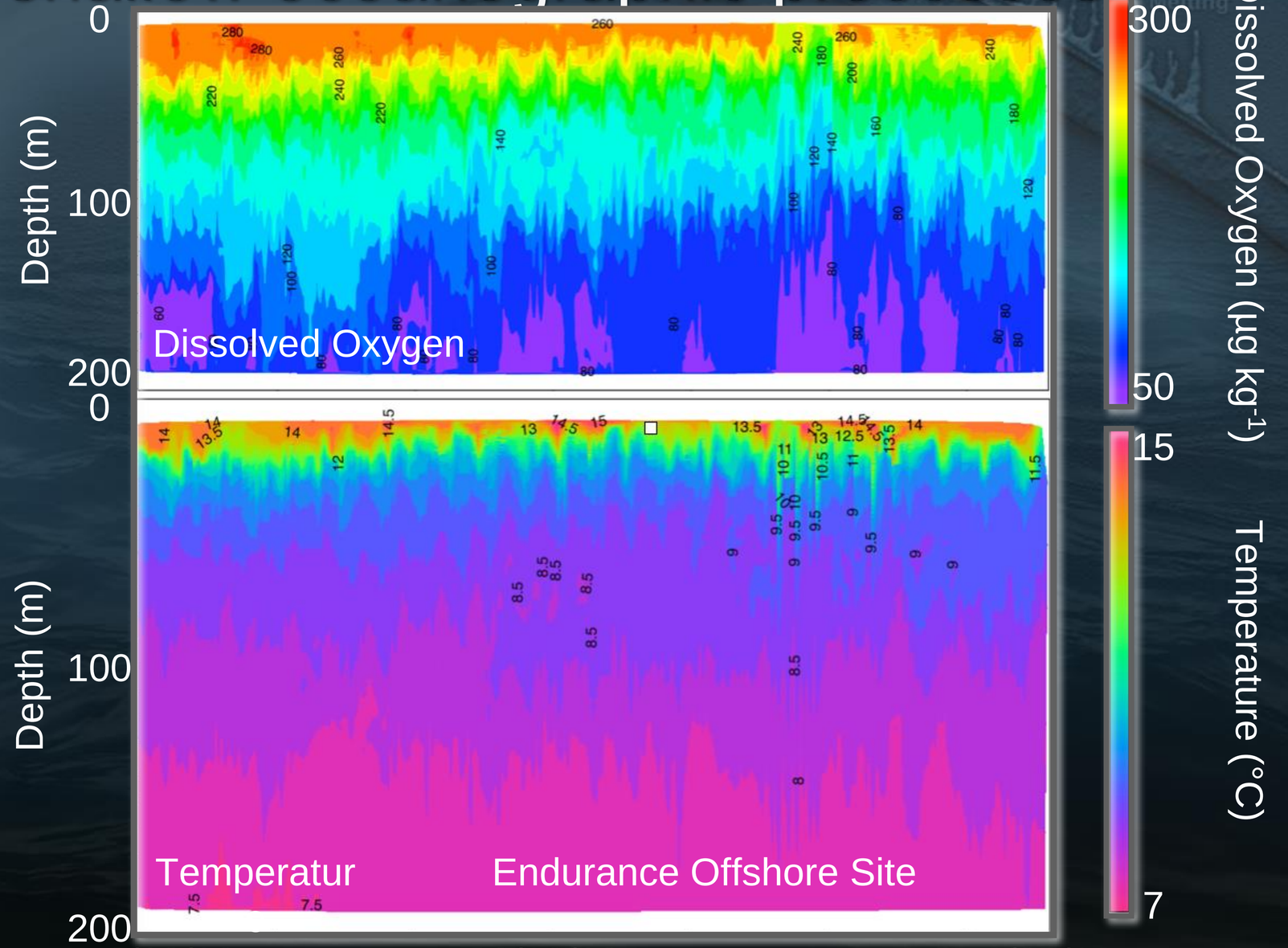


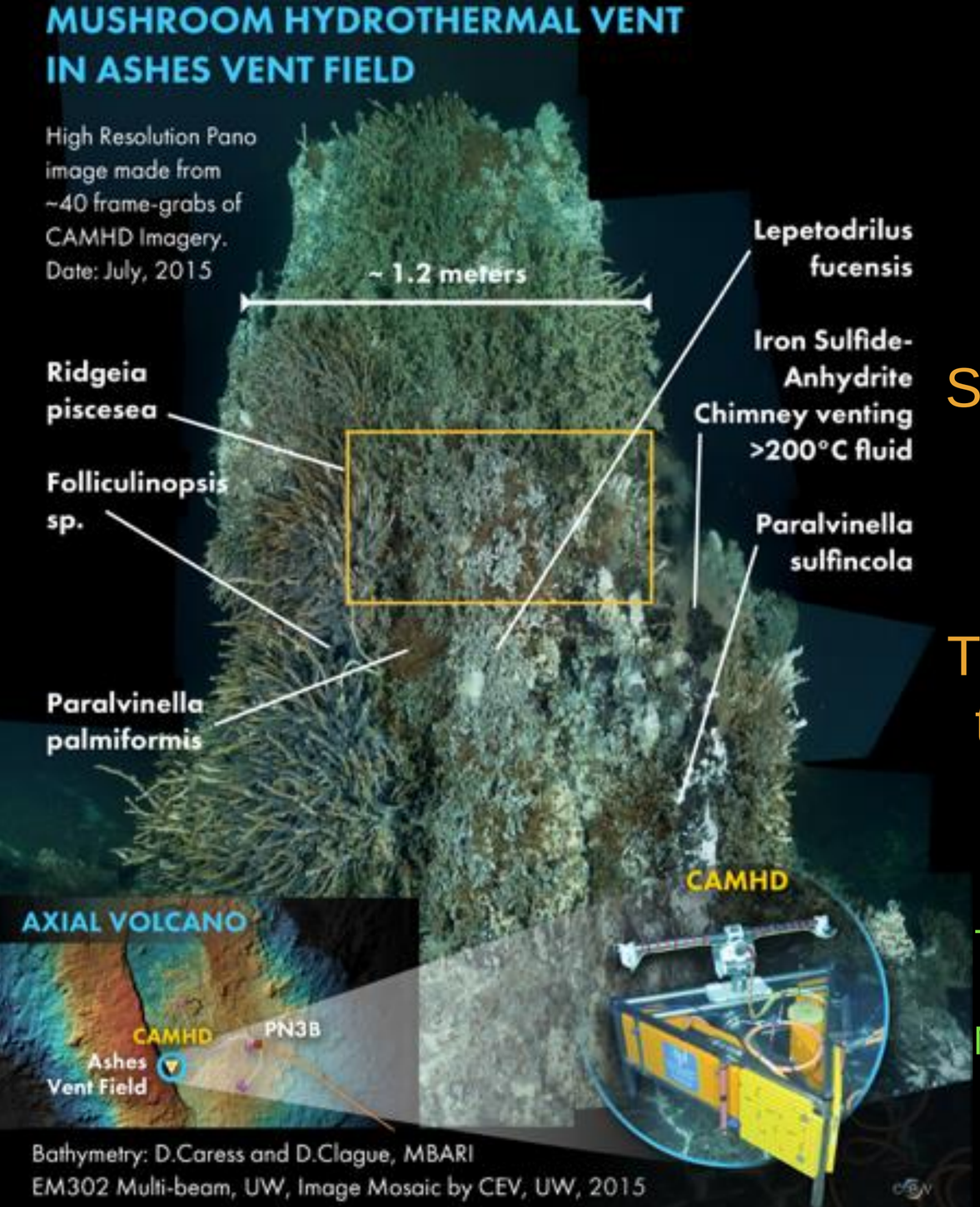
Platform Interface Controller (stationary science pod)

- pH
- broadband hydrophone
- fluormeter
- CTD-dissolved oxygen
- 5-beam ADCP
- 150 kHz ADCP
- Digital still camera

Winched Shallow Profiler

- pH
- 3W fluormeter
- CTD-dissolved oxygen
- PCO2
- nitrate
- Spectral irradiance
- PAR
- current meter+ temperature





Time-series High Definition Imagery of the “Mushroom” Hydrothermal Vent Structure in Ashes Field, Axial Volcano - JDF Ridge

Time interval: Nov, 2015 to July 20, 2016 - *One frame* every 3 hours

Video Assembled by
Tim Crone and Friedrich Knuth

Music: Flight of the Bumblebee
by Rimsky-Korsakov

Expansion of Cabled Array - PI Instruments >$13M outside investment

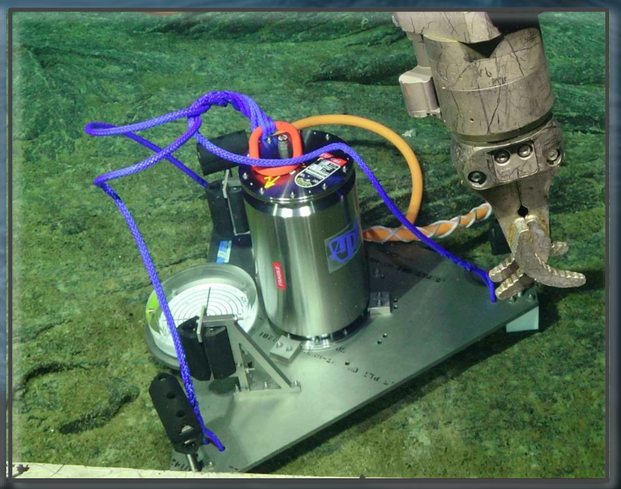
11 P.I. Instruments Now On Cabled Array

- 2017: Chadwick (OSU-NSF) Bottom Pressure Tilt and CTD - ASHES
- 2018: Bemis (Rutgers-NSF) COVIS Flow Imaging Sonar - ASHES
- 2018: Kawaguchi and Zumberge (UCSD-NSF) Self Calibrating Pressure Instrument - Central Caldera
- 2018: Wilcock (UW-NSF) Flipping Tilt Meter Central Caldera
- 2018: Breedlove (ONR) Vent Energy Harvester (platform)
- 3 uncabled thermistor array

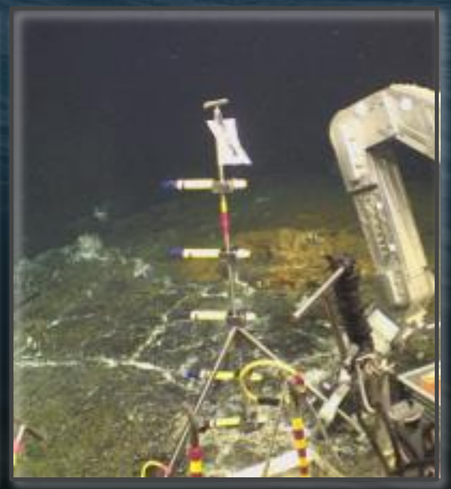
BOTPT

COVIS

Self Calibrating

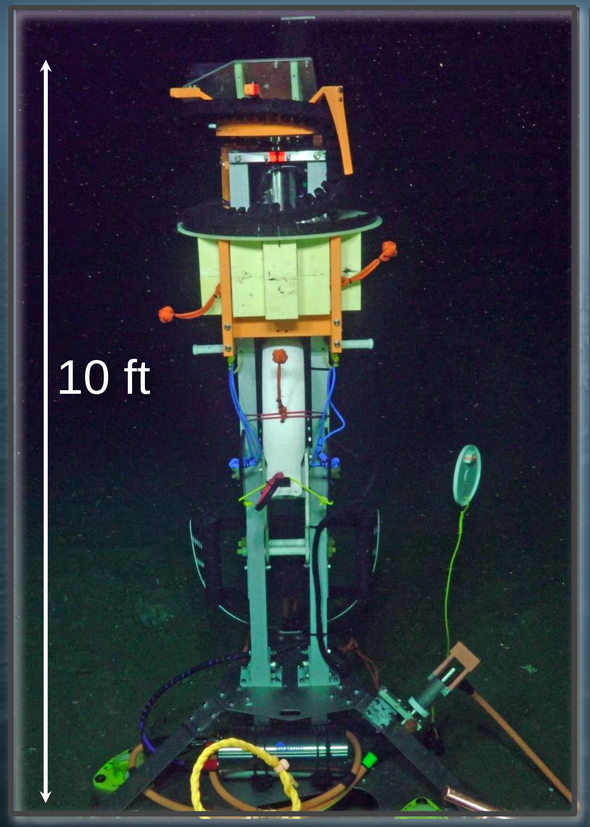


Flipper

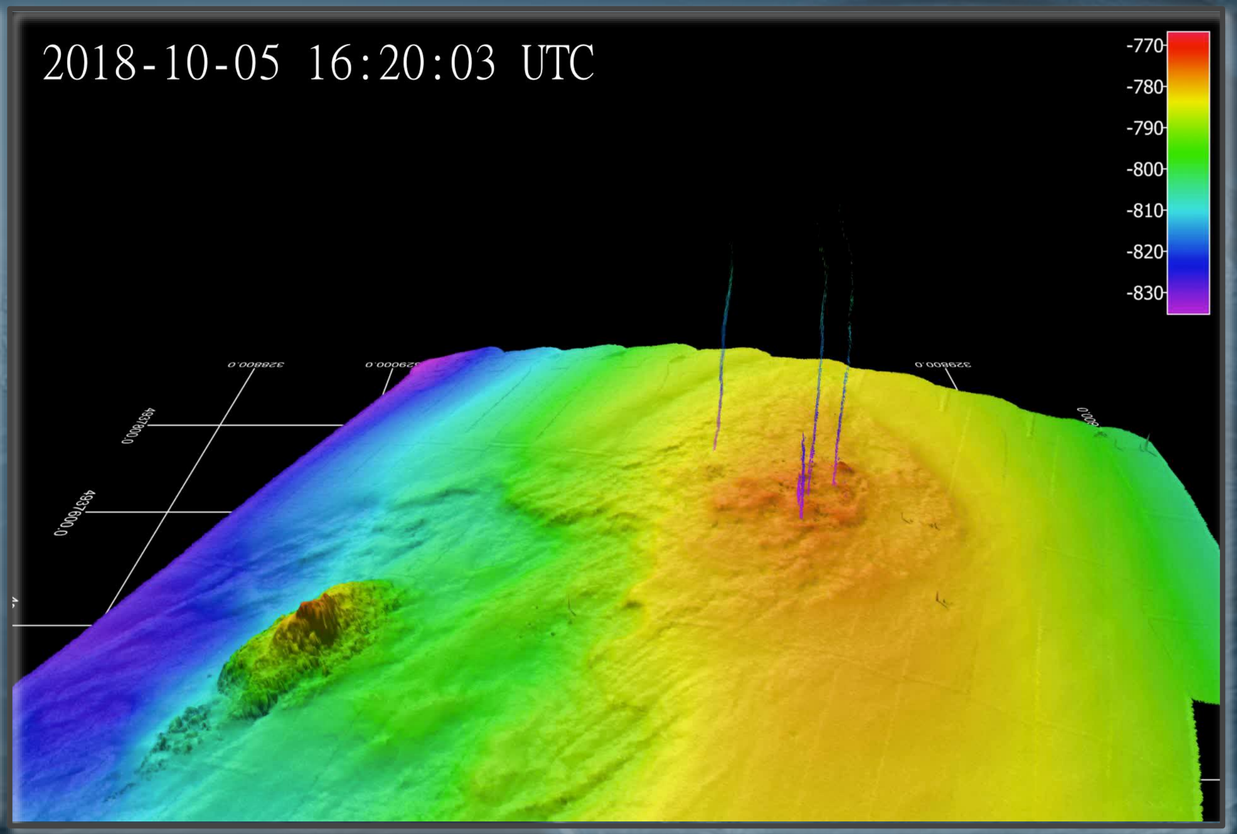


Thermistor Arrays

Quantifying Gas Emissions at Southern Hydrate Ridge - 3 yrs^{+} (MARUM; Y. Marcon and G. Bohrmann)

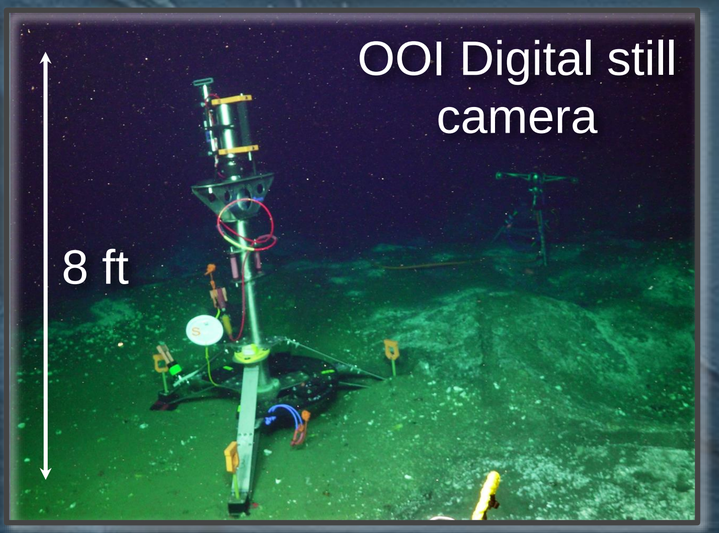


Multibeam sonar, ~ 250 m range, every 2 hrs for ~ 12 minutes



- Unprecedented 360° imaging of all methane plumes issuing from SHR! Also installed CTD-O_2 instrument
- 2019 4K video camera & refresh 1 sonar
- 2020 possible recovery cruise - funding at MARUM

Einsteins' Grotto



Centimeter resolution

Sampling bubbles - hydrate

Future Plans

2018 Workshop

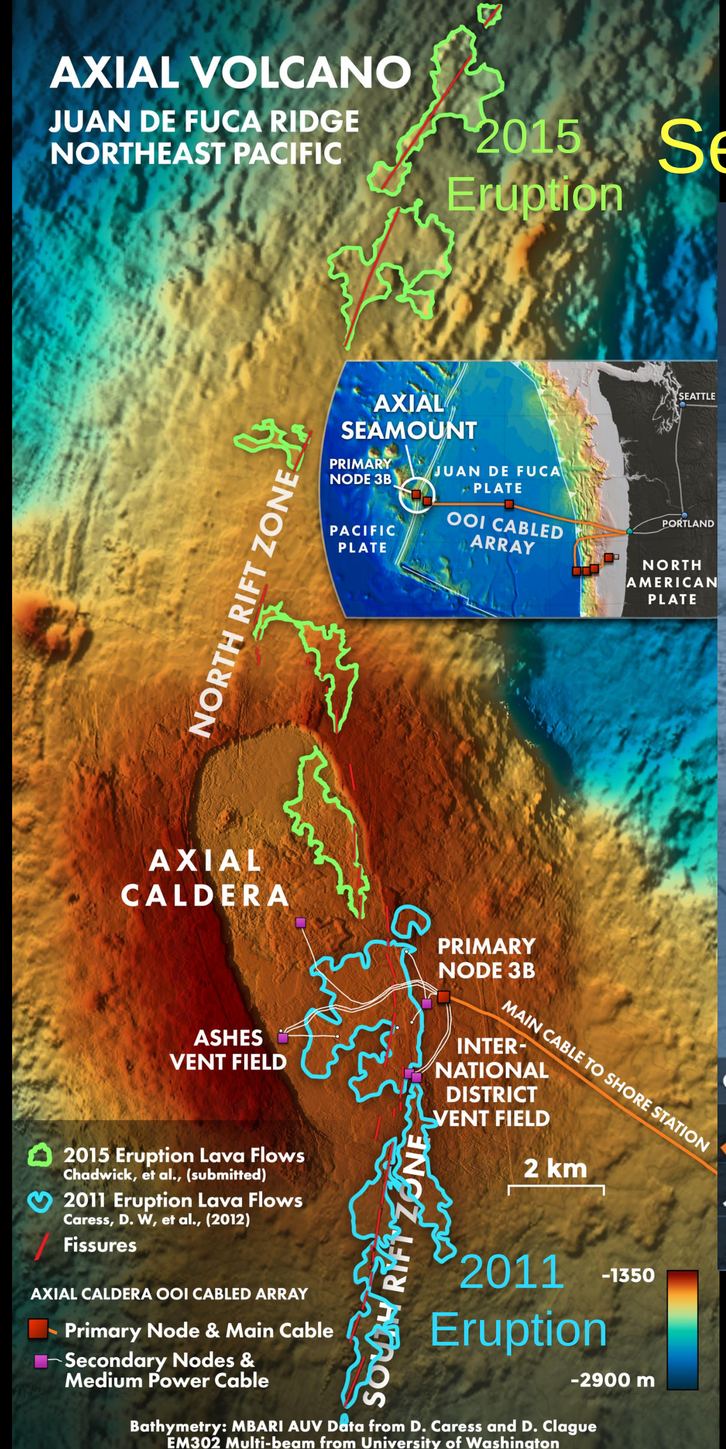
“RESIDENT AUV” & DOCKING STATION

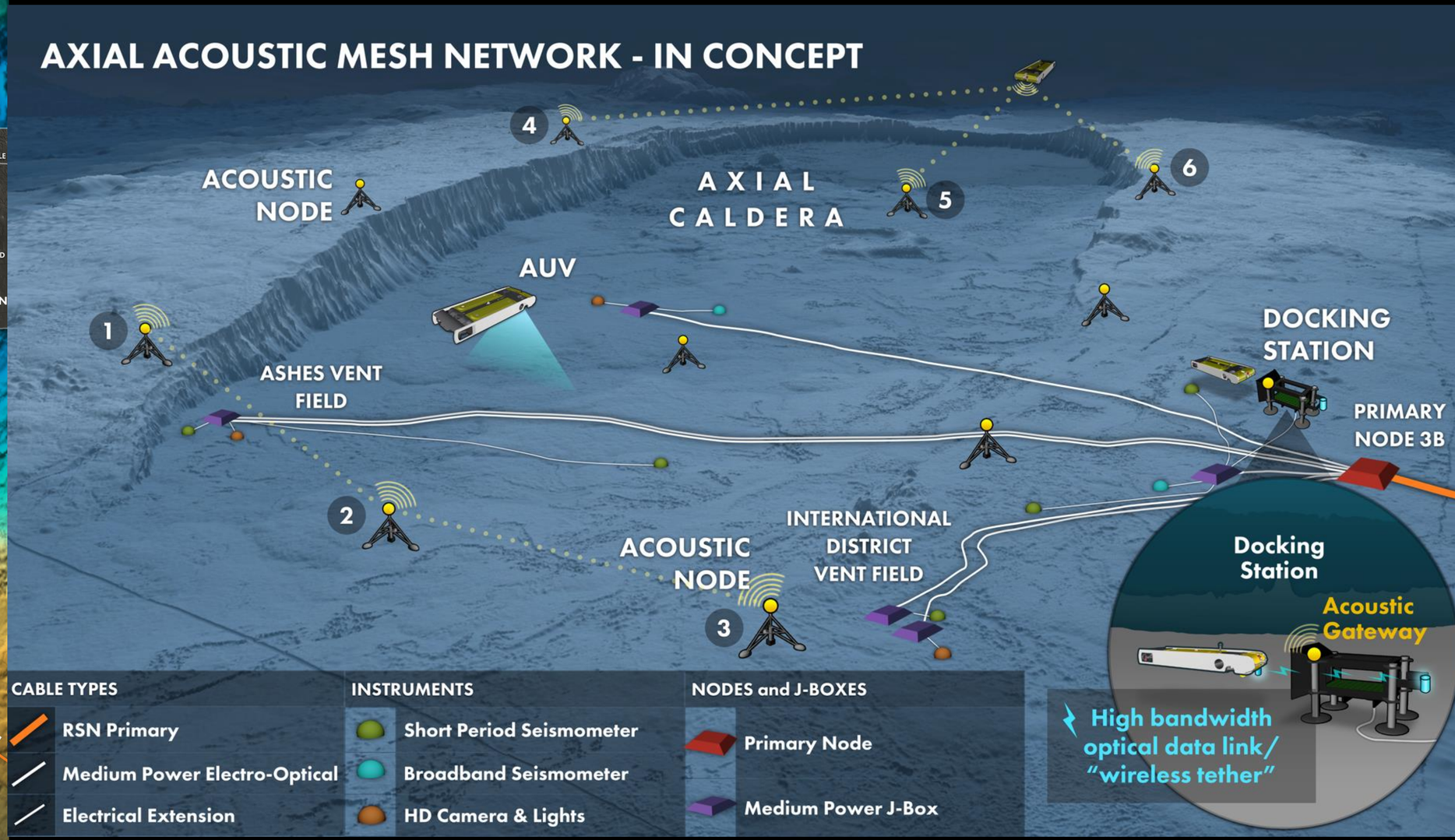
WHAT: Continuously interactive, persistent, remote, “RESIDENT-AUV” controllable from shore (400 km away).

WHERE: On a Wired and Restless Mid-Ocean Ridge Volcano - Juan de Fuca Ridge;

WHY: *First-Ever Quantification of Mid-Ocean Ridge Eruption & Full Impacts on Marine ecosystems..*

A **Resident AUV**** Permanently Deployed on Axial Seamount, semi-autonomous, but controllable from sho



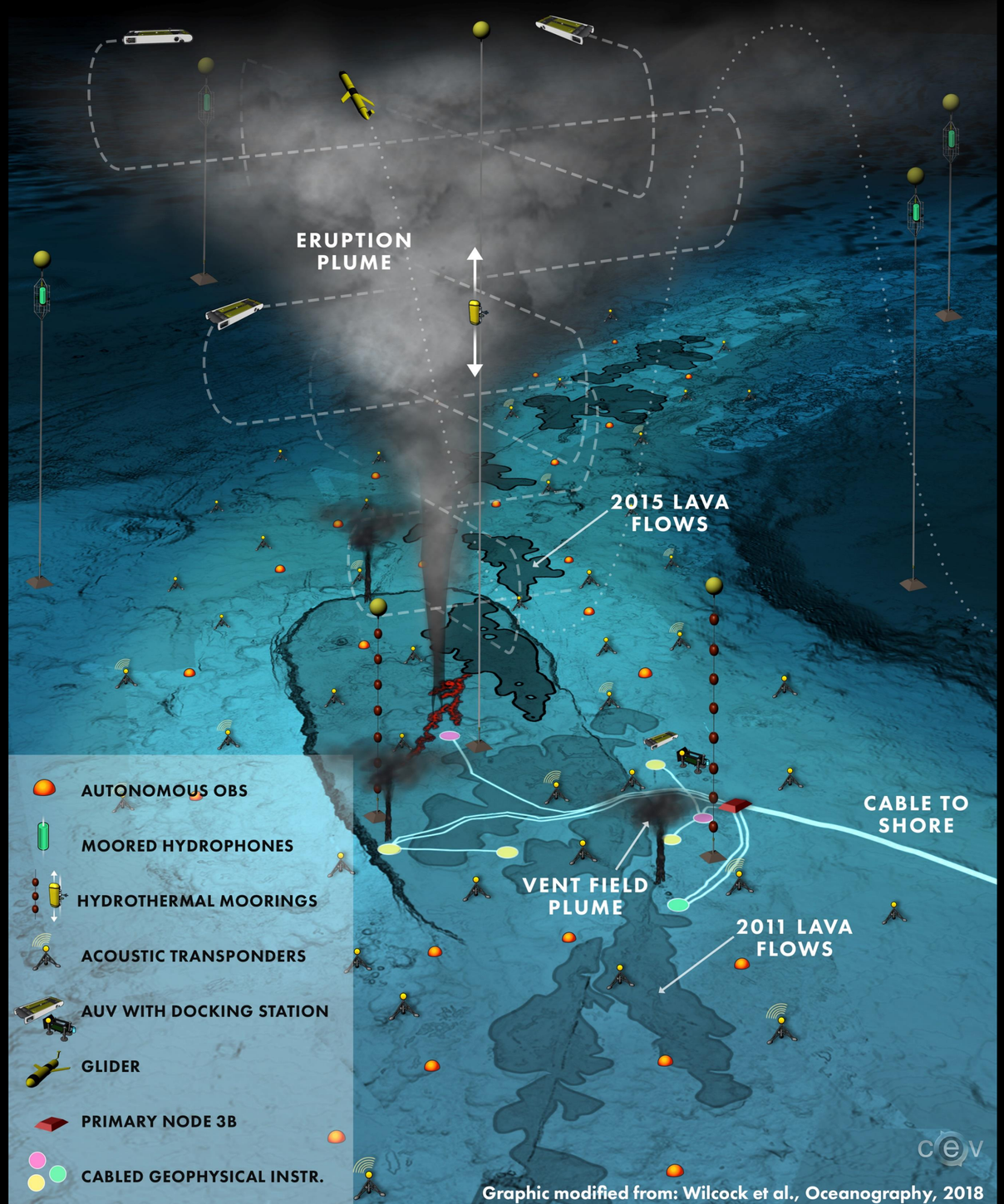


** Autonomous Undersea Vehicle

Manalang and Delaney, 2016

MAJOR SCIENCE GOAL

Real-time, autonomous tracking of a rapidly evolving seafloor/water column interaction, involving dramatic changes in heat, chemistry, microbial organisms and the adjacent marine ecosystems



EXISTING COMPONENTS:

Overall OOI Cable Construction Cost ~ $240 M; O&M ~ $10 M/year; Lifetime ~25 years.

- **NSF OOI Cable,** in place since 2014;
- **Operational Shore Station,** with links to UW & Internet
- **7 Primary Nodes,** 8kW DC Power 10 Gbps Bandwidth;
- **Axial Primary Node 3B,** 22 instruments in Caldera;
- **Annual O & M Cruise** - ~ 35 days mid-summer;
- **Data management system,** with User base growing;
- **Engineering &Management Team,** UW-APL & UW Ocean