OS51B-1482. The Next Decade of Observations at Axial Seamount: A Geophysical Perspective

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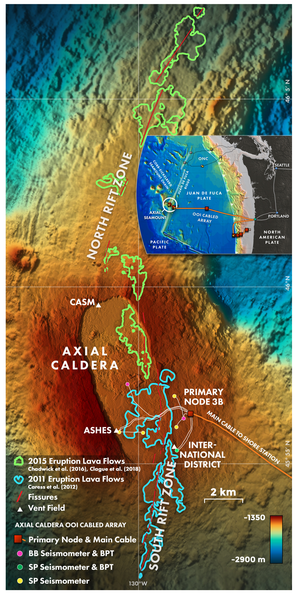
Axial Seamount has a number of attributes that make it an ideal site to study submarine volcano dynamics:

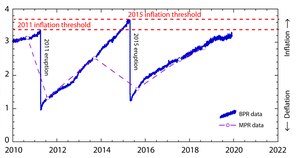
- The volcano has been extensively characterized with sustained geophysical monitoring for ~30 years.
- The magmatic system is remarkably well imaged (Arnulf et al., OS51B-1483).
- Eruptions appear predictable with the next eruption expected in just a few years (Chadwick et al., OS51B-1489).
- The Ocean Observatories Initiative (OOI) Cabled Array provides unprecedented bandwidth, power and real time capabilities and is presently supporting:
  - long term observations with a suite of standard seismic, acoustic and geodetic sensors as well as a variety of sensors in two hydrothermal vent fields.
  - deployments and testing of new instruments (Cook et al., OS51B-1488; Fredrickson et al., OS51B-1490; Xu et al., OS51B-1492).



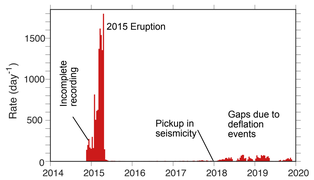
Future experiments at Axial could include:

- Deployments of autonomous seismic, acoustic and geodetic sensors timed to coincide with future eruptions.
- Installations of cabled moorings and deployments of autonomous vehicles to understanding the formation of event plumes during volcanic eruptions and their role in flushing out fluids and microbes from the subsurface.
- Emerging observational technologies that take advantage of the capabilities of the OOI Cabled Array such as resident autonomous underwater vehicles and distributed acoustic sensing.
- Instrumented boreholes that would employ the OOI Cabled Array to support novel interactive microbial and hydrologic experiments in the subseafloor.

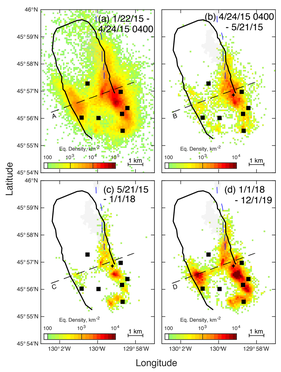
Ongoing Geophysical Monitoring

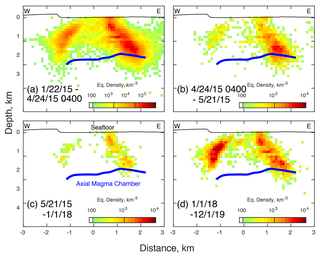


Record of inflation and deflation at Axial Seamount (courtesy of Bill Chadwick).



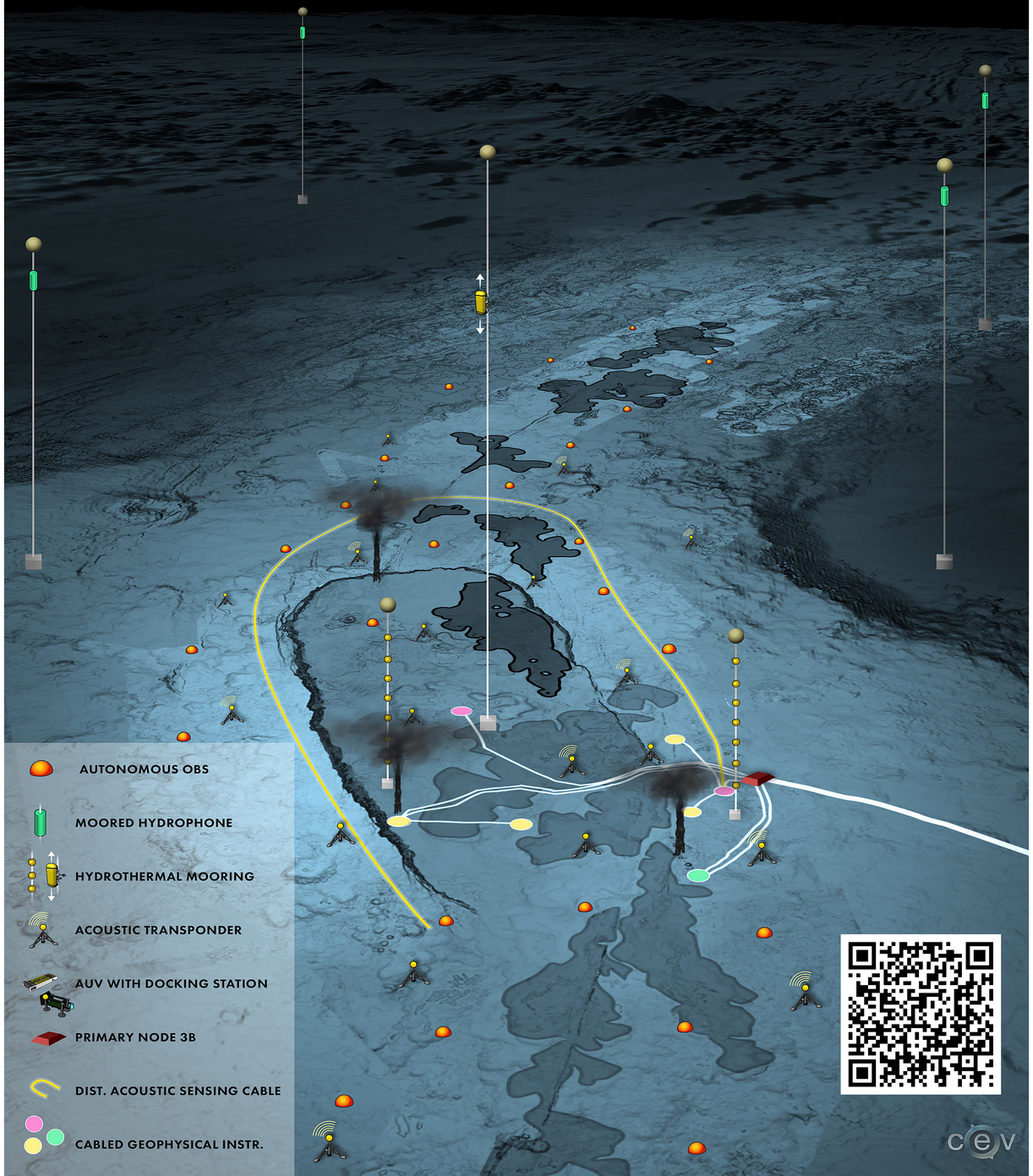
Histogram of earthquake rates averaged in 10-day bins.





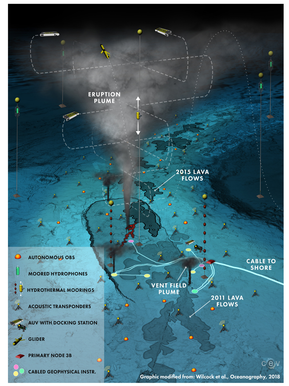
(left) Maps and **(above)** cross sections of earthquake density for four time intervals.

Axial Seamount provides remarkable opportunities for future geophysical experiments

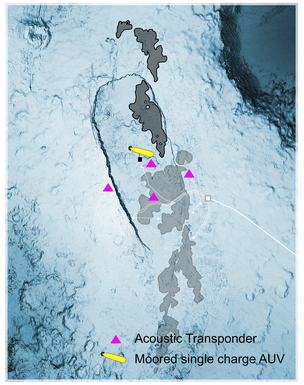


Understanding Event Plume Generation

- More than 30 years after their discover the formation mechanism of event plumes and the relative importance of surface lava cooling and subsurface fluid expulsion is still poorly understood.
- Given the need to be on site when they form, moorings and in situ autonomous underwater vehicles (AUVs) are the best ways to capture event plume formation.
- The first resident AUV could be a one-mission vehicle.



Conceptualized response to an event plume (courtesy of John Delaney and Dana Manalang).



A simple acoustic ranging and single-use AUV experiment (based on discussion with D. Manalang).

Distributed Acoustic Sensing (DAS)

Axial Seamout is an excellent site for a long-term DAS experiment:

- DAS turns each few meters of a dark optical fiber into a sensor that measures horizontal strain rates at frequencies ranging from DC to several kilohertz.
- The very high data rates of DAS can be supported by the OOI Cabled Array.
- A wider range of applications to seismology, geodesy and acoustics could be tested.

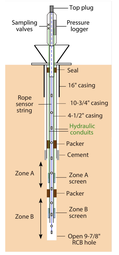
Possible layout for an ROV laid DAS Cable at Axial Seamount.

DAS recording of an earthquake from a 4-day experiment on the MARS cabled observatory (reproduced from Lindsey et al., *Science, 366*, 1103-1107, 2019).

Ocean Drilling

An IODP pre-proposal for drilling and cabled borehole observatories at Axial Seamount was submitted by a team led by Julie Huber with the goals of studying:

- Structure and composition of zero age upper oceanic crust.
- 3-D architecture of an active hydrothermal system.
- Distribution and composition of crustal subseafloor microbial communities.



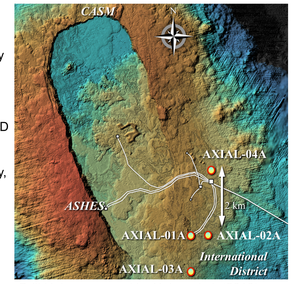
Schematic of a CORK borehole observatory (from Solomon et al., 2019)

AXIAL-01A, Center of International District hydrothermal field. Anatomy of a high T hydrothermal system

AXIAL-02A, 500 m east. Diffuse venting and upflow zone, lateral connectivity, 3-D architecture.

Axial-03A, 1 km south. 3-D architecture and connectivity, location of deep hole to investigate layer 2A/B boundary

Axial-04A, 2 km north. Seismically active zone for broadband borehole seismometer.



Drill Holes proposed by Huber et al. (2019).