Preparing for the Next Eruption of Axial Seamount



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Axial Seamount



1998 Eruption



Dziak et al (1999), Dziak and Fox (1999) Fox (1999)



1998 Eruption





Inflation up until the OOI RCA installation



"So our new forecast is for the next eruption at Axial to occur between now and the end of 2015." – Bill Chadwick, MBARI, Sept 24, 2014

Courtesy of Bill Chadwick and Scott Nooner

Axial Seamount Cabled Seismic Network



Earthquake Histogram







-130°00'

Outward-Dipping Ring Fault





NORMAL () REVERSE () STRIKE-SLIP ()

-130°00'

25 Jan - 23 April Inflation gives rise to normal faulting on outward-dipping ring faults



24 April - 19 May Deflation gives rise to reverse faulting on outward-dipping ring faults



Levy et al. (2018)

Release of subsurface brine?



BPR temperature data 4.5 April 4.0 24 Temperature (C) 3.5 3.0 2.5 2.0 4/1/2015 5/1/2015 6/1/2015 7/1/2015 Date courtesy of Bill Chadwick







Slowing Inflation since the 2015 eruption



Poster: Chadwick et al., Inflation at Axial Seamount Since its 2015 Eruption.

Seismic imaging of the internal workings of Axial Seamount

Adrien Arnulf, Steffen Saustrup, Alistair Harding, Graham Kent, Suzanne Carbotte, Michelle Liee, Tanner Eischen



Slide courtesy of Adrien Arnulf

Seismic structure of Axial Seamount, Juan de Fuca ridge



Seismic structure of Axial Seamount, Juan de Fuca ridge

Axial Seamount – MGL1905:

3D perspective view



Slide courtesy of Adrien Arnulf

2-Year Autonomous OBS Network

Proposal written when inflation-predictable model predicted eruption in 2022-2023. Deployment postponed to September 2022

Objectives include

- Capturing the next eruption
- Constraining active faulting in the northern caldera
- Searching for deep signals associated with magma recharge
- Expanding ambient cross-correlation noise observations

Poster: Lee et al., Annual and long-term seismic velocity variations at Axial Seamount observed with seismic ambient noise.



Seismic Computational Platform for Empowering Discovery



Carl Tape Ebru Bozdag Marine Denolle Felix Waldhauser Ian Wang



Axial Seamount being used by to advance big data analytics and seismic source monitoring goals



Waldhauser et al. (2020)



Slide courtesy of Kaiwen Wang, SSA meeting, 2022

Accuracy of ML Picker

- PhaseNet (trained on California earthquakes) performs well with OBS recordings without retraining.
- Evaluate pick uncertainty against cc delay times
- ML picks smaller events with higher accuracy
- Rapid catalog generation for the OBS network



Slide courtesy of Kaiwen Wang, SSA meeting, 2022

Double difference locations

Earthquake density in 25×25 m bins for 2014-2021



Poster: Zhang et al., A Plan for Automatic Focal Mechanisms at Axial Seamount.

Monitoring of Hydrothermal Discharge with a Cabled Imaging Sonar



COVIS is currently connected to the OOI Regional Cabled Array observatory at the ASHES vent field on Axial Seamount. COVIS records acoustic backscatter from both the seafloor and the water column to image buoyant plumes and map seafloor sources of hydrothermal discharge. Slide courtesy of Karen Bemis

Poster: Bemis et al., Using acoustic imaging to monitor focused and diffuse hydrothermal venting.

Monitoring Hydrothermal Fluid Temperature and Upflow-zone Permeability in Relation to Magma Movement at Axial Seamount





Increase in the phase of tidal oscillations in vent-fluid temperature after the 2015 eruption suggests a decrease in crustal permeability.

Multiple MISO high-temperature loggers will be deployed at Axial in summer 2022 !!!

Slide courtesy of Guangyu Xu

Measuring Vertical Deformation Through Repeated AUV Bathymetric Surveys

David Caress, Bill Chadwick, Scott Nooner, David Clague, Jenny Paduan



WHOI AUV Sentry: 2015, 2017, 2020, 2022 MBARI Mapping AUV: 2016, 2018, 2019





Current Repeat Survey Pattern





Manalang and Wilcock

RESIDENT AUV SYSTEM

The docking

SEAGLIDER 🍸

Hypothetical formation of a Mega Plume during an eruption at Axial Seamount

Conclusions

- The slowed inflation of Axial Seamount increases both the likely timeline of the next eruption and uncertainty of predictions.
- It makes capturing the eruption with short term deployments of autonomous sensors harder although we will likely have some warning from rapidly accelerating earthquake rates.
- It does provide more time to enhance the sensor network.
- Maybe we will have a resident AUV and instrumented drill holes in time for next eruption.

Poster: Huber and Soule, *Integrating subseafloor microbial, hydrological, geochemical, and geophysical processes in zero-age, hydrothermally active oceanic crust at Axial Seamount, Juan de Fuca Ridge.*