



# WOODS HOLE OCEANOGRAPHIC INSTITUTION

*Robert S.C. Munier, Vice President for Marine Facilities and Operations*

28 October 2019

Captain Allan Lunt  
R/V *Atlantis*, Voyage #AT42-19  
Woods Hole Oceanographic Institution  
Mail Stop #27  
Woods Hole, MA 02543

Dear Captain Lunt:

On or about 29 October 2019, your vessel being ready for sea and weather permitting, you will depart San Diego, CA on Voyage #AT42-19. Upon completion of science activities, the vessel shall return to the port of San Diego, CA. You may plan to arrive in San Diego on or about 10 November 2019.

## **Science Objectives**

Science objective will address the following hypotheses:

H1. Benthic microbial mats serve as the primary sink for nitrate in the deep Santa Barbara Basin, through active hyper accumulation and spatial focusing of nitrogen redox transformations.

H2. Sulfide production in the uppermost sediment horizons increases with microbial mat coverage, because mats selectively inhibit the flux of terminal electron acceptors (i.e oxygen, nitrate, and nitrite) into the sediment, thereby stimulating the remineralization of organic matter mainly by sulfate reduction.

H3. The benthic mat feedback is a scalable, regional phenomenon, modulated by nitrate and oxygen concentration dynamics within the water column.

We propose a combination of field and laboratory studies as a means to address these questions and test our hypotheses.

Hypothesis H-1 will be tested directly by two in-situ approaches. The first approach relies on in-situ measurements of uptake and release of nitrate, ammonium, and other relevant solutes at the sediment surface with an ROV-deployed benthic chamber system, yielding areal uptake/release rates (e.g., mol m<sup>-2</sup> h<sup>-1</sup>). The second approach relies on in-situ injection of <sup>15</sup>N-nitrate to the chamber, incubation for a known time, and time series collection of the water from the chamber. By this method, the uptake rate of nitrate can be quantified along with the release rate of transformation products from DNRA and denitrification. The two approaches will be part of both proposed expeditions, providing for hypothesis tests under contrasting oceanographic conditions,

i.e., following deoxygenation and reoxygenation. Uptake rates quantified by both approaches can be spatially averaged and scaled to the basin; the comparison of these rates to basin-wide nitrate decline provides a second test of H-1. By these methods, we will calculate the fraction of nitrate loss from the SBB that goes through bacterial mats.

Hypothesis H-2 will be tested by comparing the depth distributions of sulfate reduction activity and sulfate-reducing bacteria in contrasting sediment cores collected during mat and no mat conditions (matching H-1 locations). The approach will be repeated by seasonal sampling of cores from locations that featured mat and no mat conditions through time. Multiple direct hypothesis tests will be performed through a series of one-to-one comparisons for cores collected along repeat transects during opposing seasons. By this approach, we predict greater rates of sulfate reduction in uppermost sediment horizons (e.g., in the top eight centimeters of the core) with the presence of microbial mats, and observations to this effect would serve as a test of the null to hypothesis H-2. That is, the rate comparison serves as direct test of H-2, but the anticipated results more formally serve as a test of the null hypothesis.

Hypothesis H-3 will be tested by conducting a series of photo-imaging surveys of the SBB seafloor using the AUV Sentry. Through these surveys we will assess (1) whether mats occur in a concentric pattern around the depocenter of the Santa Barbara Basin; (2) whether their distribution on the slope of the SBB matches with the depths of active nitrate loss from the water column; (3) whether their lower bound corresponds to nitrate depletion from the water; and (4) whether their upper boundary corresponds to the oxycline. The comparison of water-column oxygen and nitrate concentration distributions with the observed distribution of microbial mats provides the basis to test H-3.

### **Science Activities**

In support of our hypotheses, we plan a combination of sediment and water column activities as described below.

#### **Jason Operations:**

We plan a series of benthic transects in the Santa Barbara Basin, using Jason to collect sediment cores and water samples and for the deployment/recovery of benthic landers (3) and microprofilers (2). Along each transect we will conduct multiple deployments. Our operational area is limited by bathymetry and the locations of the two shipping lanes.

We plan to operate three Benthic Chamber Modules during the expeditions to for in-situ incubations. Our collaborator who developed the chambers is located at the AWI, and we have put him in initial contact with the Jason team. Modules will be deployed by Jason and may be sent to the bottom either on the elevator or directly attached to Jason. We envision a combination where one module may be attached to the front porch of Jason during Jason deployment, and the other modules sent down later in the dive using the elevator. At the seafloor, Jason will place modules on the sediment surface and pick them up later. We anticipate benthic chamber recoveries to the vessel using both Jason (attached to the front porch) and the elevators as well. In addition to the benthic chambers, our collaborator will also provide microprofilers that will be treated the same as the benthic landers inasmuch as deployments and

recoveries are concerned. Both systems have been used extensively with other ROV systems, but not with Jason. During the Jason operations we also plan to collect sediment push cores, water samples and microbial mat samples if possible. Jason may also encounter and sample hydrocarbon seeps.

### Sentry Operations

Sentry will be used primarily for benthic imaging surveys, effectively flying the same transects as Jason, to image microbial mats on the seafloor.

*R/V Atlantis*

Voyage #AT-42-19

29 October 2019 – 10 November 2019

San Diego, CA – San Diego, CA

Scientific personnel participating on this cruise under the direction of Dr. David Valentine, University of California, Santa Barbara, will be:

Dr. David Valentine, Chief Scientist, UC Santa Barbara  
Dr. Frank Kinnaman, UC Santa Barbara  
Dr. Xuefeng Nick Peng, UC Santa Barbara  
Dr. Molly O'Beirne, UC Santa Barbara  
Kelsey Gosselin, UC Santa Barbara  
Alec Vallota-Eastman, UC Santa Barbara  
Qianhui “Emma” Qin, UC Santa Barbara  
Eleanor Arrington, UC Santa Barbara  
Jonathan Tarn, UC Santa Barbara  
Na Liu, UC Santa Barbara  
Shey Droji, UC Santa Barbara  
Joshua Burgos-Ponce, UC Santa Barbara  
Hailie Kittner, UC Santa Barbara  
Xiadani Moreno, UC Santa Barbara  
Aran Mazariegos, UC Santa Barbara  
Elizabeth Weidner, University of New Hampshire  
Dr. Tina Treude, UCLA  
Sebastian Krause, UCLA  
De'Marcus Robinson, UCLA  
David Yousavich, UCLA  
Dr. Frank Wenzhoefer, Alfred Wegener Institute Bremerhaven  
Dr. Felix Janssen, Alfred Wegener Institute Bremerhaven  
Tito Collasius, Woods Hole Oceanographic Institution  
Korey Verhein, Woods Hole Oceanographic Institution  
Jim Convery, Woods Hole Oceanographic Institution  
Mario Fernandez, Woods Hole Oceanographic Institution  
Ryan Govostes, Woods Hole Oceanographic Institution  
Fred Denton, Woods Hole Oceanographic Institution  
Rick Sanger, Woods Hole Oceanographic Institution

Scott McCue, Woods Hole Oceanographic Institution  
James Pelowski, Woods Hole Oceanographic Institution  
Benjamin Tradd, Woods Hole Oceanographic Institution  
Justin Fujii, Woods Hole Oceanographic Institution  
Michael Skowronski, Woods Hole Oceanographic Institution  
Stefano Suman, Woods Hole Oceanographic Institution  
Michael McCarthy, Woods Hole Oceanographic Institution  
Laura Lindzey, Woods Hole Oceanographic Institution  
Allison Heater, Woods Hole Oceanographic Institution  
Rebecca Hudak, Woods Hole Oceanographic Institution

The ship's agent in San Diego, CA will be:

Master R/V Atlantis  
Attn: Dr. David Valentine  
c/o Paxton, Shreve & Hays Inc.  
453 54th Street Suite 101  
San Diego, CA 92114

Contact: Tom Jenkins  
Phone: (619) 232-8941  
Cell: (619) 232-3006  
E-mail: [marineops@pshinc.net](mailto:marineops@pshinc.net)

Please note: At the completion of this voyage, the Captain should complete a Post-Cruise Assessment form online at the following web site:

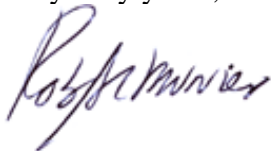
[http://strs.unols.org/Public/diu\\_faq\\_view.aspx?short=HowdoIsubmitaPCAR](http://strs.unols.org/Public/diu_faq_view.aspx?short=HowdoIsubmitaPCAR)

Please advise the Port Office of all personnel changes prior to departure and maintain the daily SITREP via INMARSAT C or other means as required.

Please advise the Port Office of all significant expenses incurred, particularly the quantity, price and source of fuel oil. Also, at each port stop, please advise the Port Office the gallons of fuel on board stating the date the inventory was taken.

I wish you a pleasant and successful voyage.

Very truly yours,



Robert Munier  
Vice President  
for Marine Facilities and Operations

RM/dam