Federal Funding Opportunity Grants

Fiscal Year 2018

As part of the Fiscal Year 2018 (FY18) Federal Funding Opportunity, the NOAA Office of Ocean Exploration and Research selected 10 projects for financial support totaling approximately $4.6 million. The supported projects are described below.

Paleolandscapes and the ca. 8,000 BP shoreline, Gulf of Mexico, Outer Continental Shelf

Amanda Evans—Coastal Environments, Inc.
Budget: $596,424
Dates: April 16 - May 21, 2019 (two weeks)

The project includes geophysical survey and sediment coring, centered in, but not restricted to, the High Island federal lease area in the Gulf of Mexico. The resulting data will be used to create baseline characterizations of, and delineate archaeological horizons within, the paleolandscape associated with the shoreline stand ca. 8,000 years BP. These spatial and temporal survey areas were selected due to the previous identification of a probable midden feature and archaeological horizon offshore from cores acquired in the Sabine Pass and High Island areas, from depths of approximately 15 meters below sea level. The preliminary search area was defined using three key locations associated with potential Paleoindian and Early Archaic occupation and exploitation of the Outer Continental Shelf (OCS): the Sabine Pass core; the High Island core; and the 32 kilometer stretch of McFaddin Beach, Texas, where over 880 artifacts have washed ashore over the years, the majority of which are Paleoindian. The proposed scope of work is focused on this initial search area, which represents approximately 234 square miles on the OCS.

The motor vessel *Nikola* will be used to complete this project. *Image courtesy of BOEM and Tesla Offshore.*

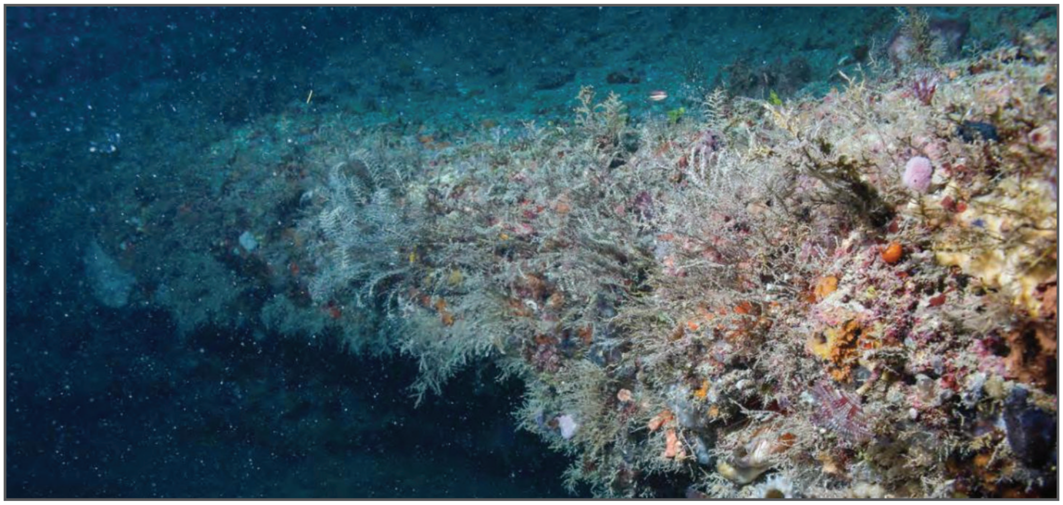
Development of innovative techniques for exploring novel submarine springs on the Gulf of Mexico Outer Continental Shelf

Emily R. Hall—Mote Marine Laboratory

Budget: $257,442

Dates: May 13 - 18, 2019

Offshore submerged sinkhole and spring features have received limited scientific study as they frequently exceed normal scuba limits, reaching depths of greater than 130 meters, and exhibit openings too small for access with many submersibles. These blue holes host several commercially important fish species and can be considered ecological hotspots with respect to species composition and diversity. Because of groundwater discharge, organic matter deposition, and circulation regimes, parameters such as temperature, salinity, light, turbidity, circulation, dissolved oxygen, pH, redox, trace metal, carbonate chemistry, and sediment types are heterogeneous and satisfy various biological niches. The principal objectives of this work are to 1) repurpose and repackage existing high-tech marine biogeochemical instrumentation for the purpose of creating a benthic lander appropriate for efficient exploration of these difficult-to-access environments; 2) show proof-of-concept by deploying the platform in conjunction with more frequent macrofauna surveys, genomics, and geochemical sampling of two known blue holes at depths greater than 100 meters; and 3) disseminate exciting data and images through innovative means that will immediately captivate the minds of the public and garner future interest from scientists.

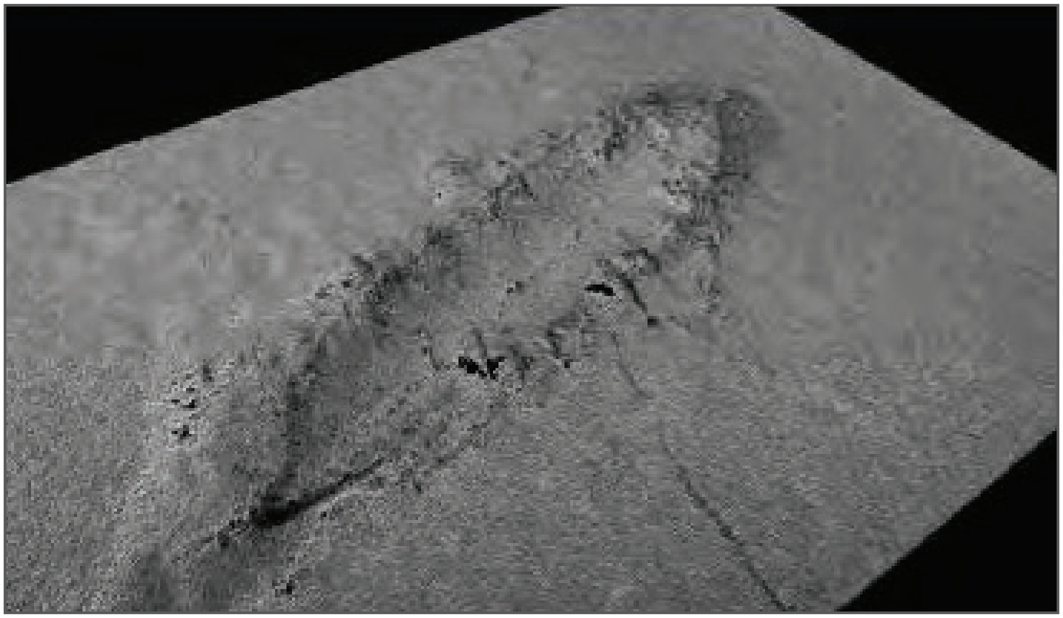


Marine organisms thrive around the rim of a blue hole, similar to the ones studied for this project. *Image courtesy of Mote Marine Lab.*

Microbial stowaways: Exploring shipwreck microbiomes in the deep Gulf of Mexico

Leila. J. Hamdan—University of Southern Mississippi
Budget: $637,469
Dates: June 24 - July 2, 2019

The geological processes that formed the Gulf of Mexico (GoM) carved canyons, escarpments, and seeps and led to the formation of specialized habitats. Exploration of the biogeography of these natural habitats has not addressed the more recently formed shipwreck habitats on the seafloor. More than 2,000 shipwrecks spanning 500 years of history were lost in the GoM. Shipwrecks become artificial reefs and islands of diversity. Macro-organism biogeography is known to be shaped by the island effect of shipwrecks in conjunction with currents. However, the effect historic shipwrecks impart on microbiomes and how they shape microbial biogeography has never been explored. The proposed work will use a cross-disciplinary approach to explore how shipwrecks and seafloor hydrodynamics shape deep-sea microbiomes, and place the remote seafloor in context with contemporary change. The work will map wreck-associated microbiomes (diversity, richness) in benthic and pelagic habitats. This study benefits from an established, interdisciplinary team (microbial ecologists and archaeologists) engaged in deep-sea shipwreck research in the northern GoM.



Sonar image of a potential wreck site. *Image courtesy of Leila. J. Hamdan.*

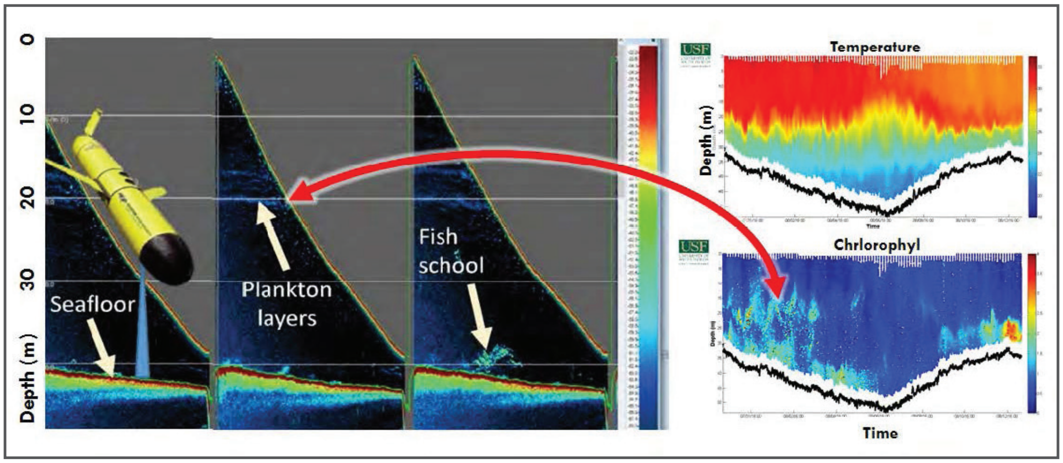
From aggregations to individuals: Exploring migrating deep sea scattering layers through multiscale-multimode technologies in the Gulf of Mexico

Kevin M. Boswell—Florida International University

Budget: $590,110

Dates: TBD, Summer 2019

The proposed exploration will address sampling resolution constraints by providing multi-scale observations of migrating Scattering Layers (SLs) in the Gulf of Mexico (GoM), obtaining simultaneous measurements of individual through aggregation dynamics using a suite of sensors on autonomous platforms. This study will explore GoM mesopelagic communities using emerging acoustic and optical sensors on autonomous platforms to discover the dynamics of these animal communities within the complex oceanography of the GoM. Specific objectives are to: 1) integrate a high-resolution, wideband echosounder within an ocean glider to explore migrating animals within mesopelagic SLs; 2) develop "on-board" acoustic data processing to facilitate adaptive exploration of migrating SL communities; and 3) integrate a swarm (~5) high-resolution autonomous optical profilers to derive non-invasive in situ validation of individuals comprising migrating SLs.



Glider-based echosounder water column biomass and water column variables simultaneously collected in coastal Florida waters. (a) Three consecutive glider descent echograms illustrating high-resolution plankton layers and fish aggregations in the water column. (b) Time series plots of temperature and fluorescence plotted over a two- week deployment. Comparing results of the acoustic biomass with other sensors increases understanding of fish and zooplankton dynamics and demonstrates the utility of combined sensor packages. *Images courtesy of Kevin Boswell*

Advancing eDNA as a tool for exploration in deepwater environments

Jill McDermott—Lehigh University
Budget: $456,983
Dates: September 20 - 27, 2019

Organisms continuously shed cells and leak DNA into their surrounding environment. The study will develop a framework to establish environmental (e)DNA metabarcoding as a standard ocean exploration tool that will enable rapid, economic, and comprehensive diversity assessments of deepwater fauna. As such, eDNA is an emerging non-invasive methodology for capturing and sequencing this DNA to rapidly explore and characterize biodiversity of an area. There are two urgent challenges to interpret eDNA sequence data obtained from deep seawater samples: 1) Understanding the temporal persistence of eDNA in the environment and 2) Performing taxonomic identification assignments for eDNA metabarcode sequences. To address these critical challenges that currently limit the use of eDNA approaches in deepwater ecosystems, this work will: 1) Quantify and predict the temporal persistence of eDNA in laboratory aquaria under a range of deepwater environmental conditions; 2) Test the eDNA metabarcoding framework in a relatively well-characterized setting (Flower Garden Banks National Marine Sanctuary, Gulf of Mexico); 3) Explore biodiversity in unknown or poorly known areas in the Gulf of Mexico and the southeastern U.S. Exclusive Economic Zone (U.S. EEZ); and 4) Improve the DNA barcode databases for corals and fishes from the Gulf of Mexico and the southeastern U.S. EEZ. The development of eDNA technology will greatly enhance our ability to explore the ocean.

Found in the Gulf of Mexico, this *Metallogorgia* sp. octocoral and commensal serpent star (*Ophiocreas* sp.) are suspected to require each others' presence to survive! *Image courtesy of the NOAA Office of Ocean Exploration and Research, Gulf of Mexico 2017.*

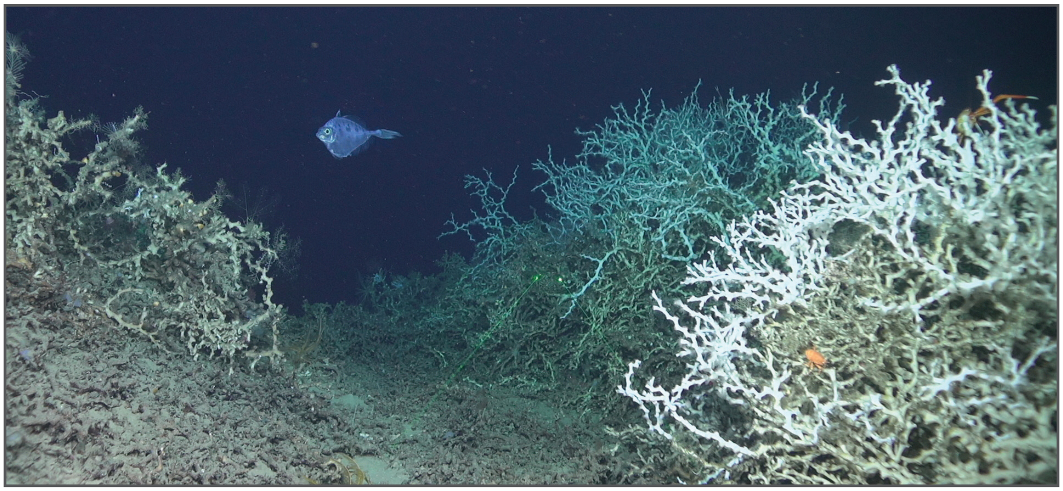
Combining habitat suitability and physical oceanographic models for targeted discovery of new benthic communities on the west Florida slope

Sandra Brooke—Florida State University

Budget: $426,316

Dates: October 1 - 10, 2019

Unlike the northern Gulf of Mexico (GoM), there has been little research effort in the eastern GoM; however, in recent years, several cruises conducted mapping and surveying of the west Florida slope (WFS) and revealed extensive deep coral habitats, including large *Lophelia* reefs. Pressure to protect deep-sea coral habitats has created a need to understand their distribution. To overcome the lack of data, Habitat Suitability Models were developed. These models may be further refined by incorporating current speed and data from oceanographic models. The proposed project focuses on the deep (greater than 1,000 meters) habitats and associated communities of the WFS. Both available habitat suitability modeling as well as a high-resolution oceanographic model will be used to select target study sites and will validate the oceanographic model in a novel approach using meiofaunal communities. The project will include generation of new information on deep coral habitats and associated communities using digital imagery and identification of species assemblages using morphological taxonomy and genetic techniques. In collaboration with NOAA, the obtained data and the high-resolution oceanographic model will refine the coral predictive habitat models for deeper portions of the GoM.



A tinselfish swims among *Lophelia* thickets at Okeanos Ridge on the West Florida slope. Tinselfish (Family Grammicolepididae) were one of the more commonly observed fish species around 500 meters depth. *Image courtesy of NOAA Southeast Deep Coral Initiative and Pelagic Research Services.*

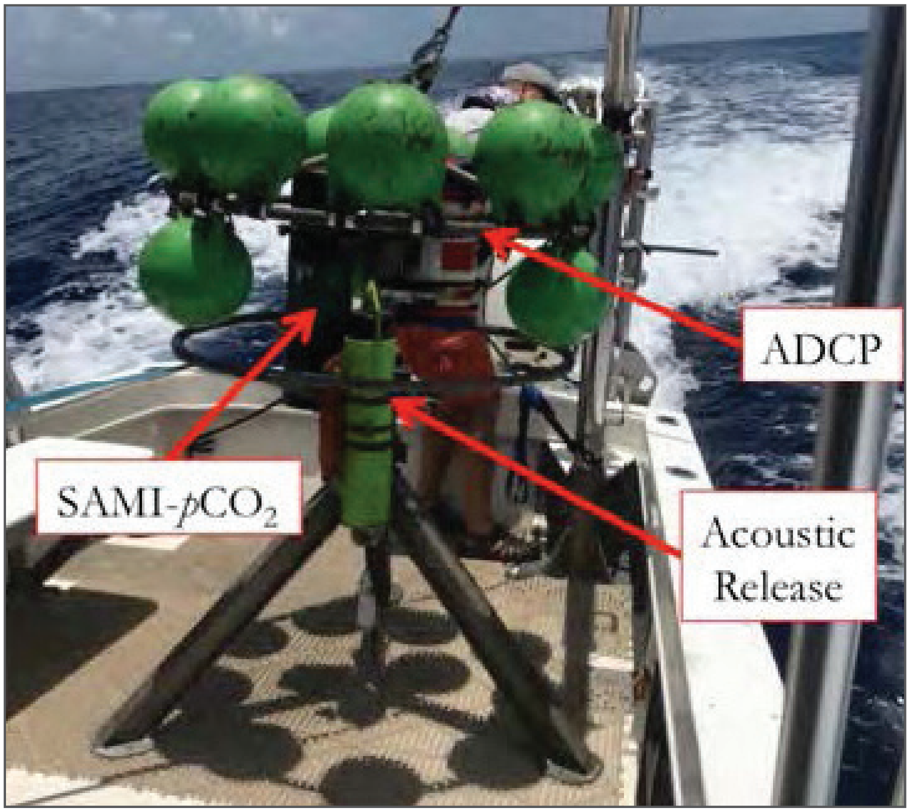
Exploration and characterization of fine scale physical biogeochemical environment over deep coral reefs on the west Florida slope using integrated ROV lander sensor systems

Zhaohui Aleck Wang—Woods Hole Oceanographic Institution

Budget: $469,003

Dates: October 11 - 17, 2019

Variability of carbonate chemistry and other environmental conditions surrounding deep-sea corals potentially plays an important role in the biology of these deep corals and their responses to unprecedented anthropogenic changes. Understanding of these dynamics and responses are critical for long-term adaptation and survival of deep corals. To fill in this knowledge gap, this project proposes to conduct a comprehensive multidisciplinary study to explore and characterize two deep coral habitats with contrasting benthic communities on the west Florida slope of the Gulf of Mexico (GoM). A newly developed *in situ* DIC-pH sensor, Channelized Optical System (CHANOS), along with additional pCO2, pH, and other sensors, will be deployed on a remotely operated vehicle (ROV) to map and fully resolve the carbonate system at the two deep coral sites by simultaneously measuring desired CO2 parameter pairs (DIC-pH and DIC-pCO2) with high resolutions (meters). Two newly developed landers equipped with state-of-the-art sensors will be deployed at the two sites over 6-8 months to capture fine-scale temporal variability (hours) of carbonate chemistry and other key parameters. This will also be accompanied by in situ experiments on deep coral growth and skeletal dissolution. This study will be the first to document such fine-scale variability around deep reef systems in the eastern GoM.

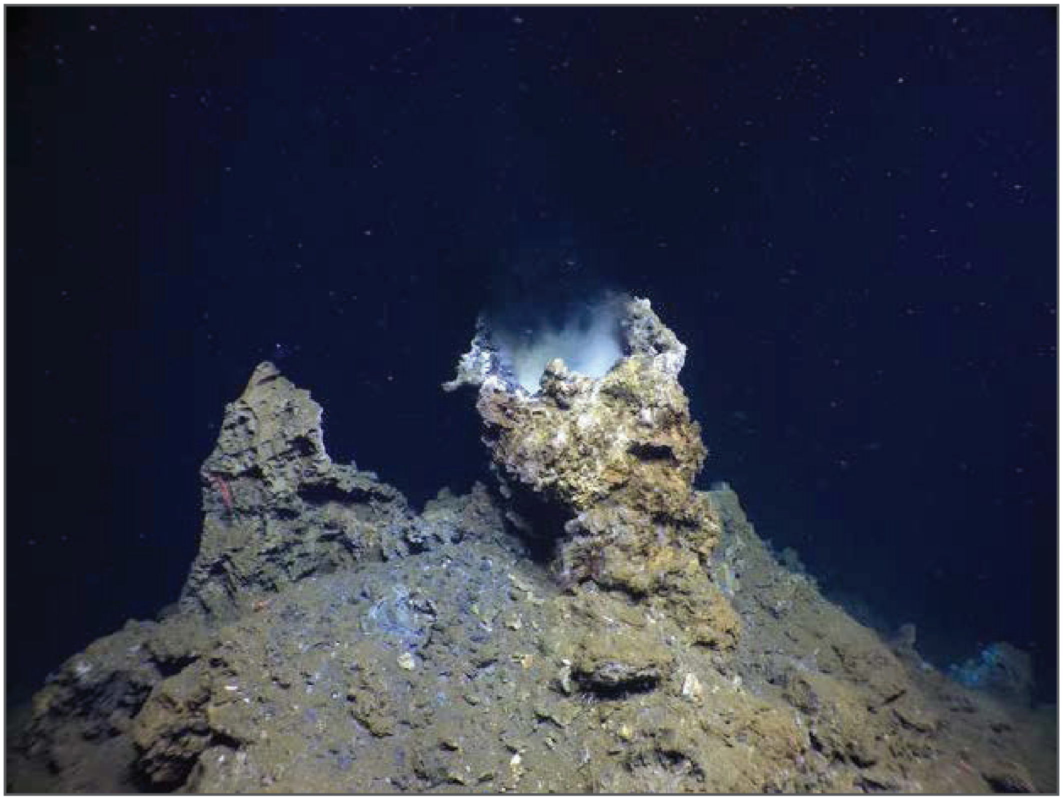


Example of the lander package for deploying the newly developed *in situ* DIC-pH sensor. *Image courtesy of Zhaohui Aleck Wang.*

Optical sensing of ocean gases using photothermal interferometry

Anna Michel—Woods Hole Oceanographic Institution
Budget: $397,948
Dates: TBD, No field work in 2019

The work will include the design, development, and field testing of a miniature ultrasensitive dissolved gas sensor that can measure carbon dioxide (CO2) and methane (CH4) *in situ*, utilizing photothermal interferometry (PTI), an optical absorption gas detection technique. This sensor will be developed for deepwater applications and will allow us to measure these important gases without the need for physical samples. The sensor will be low-cost (under $10,000); small ("soda can" size instrument); and designed for deployment using a range of platforms including remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), landers, and surface vehicles. Operating this sensor on an AUV would enable 3D chemical mapping of CH4 and CO2 in the deep ocean. Future system generations will look to also measure other important gases including N2O, NO, NH3, and H2S. The proposed project is interdisciplinary as it couples engineering, optics, and chemical sensing to develop an innovative exploration technology.



Exploration of hydrothermal vents, such as Diane's Vent at the Pescadero Vent Field, will be greatly enhanced by the development of new, highly sensitive, compact dissolved gas sensors. *Image courtesy of Ocean Exploration Trust, Woods Hole Oceanographic Institution, Dalio Foundation, Alucia Productions, Adam Soule, and the MISO Facility.*

Exploration of the deep ocean with teams of long-endurance ocean robots

Michael V. Jakuba—Woods Hole Oceanographic Institution

Budget: $597,212

Dates: TBD, Field work planned for 2021

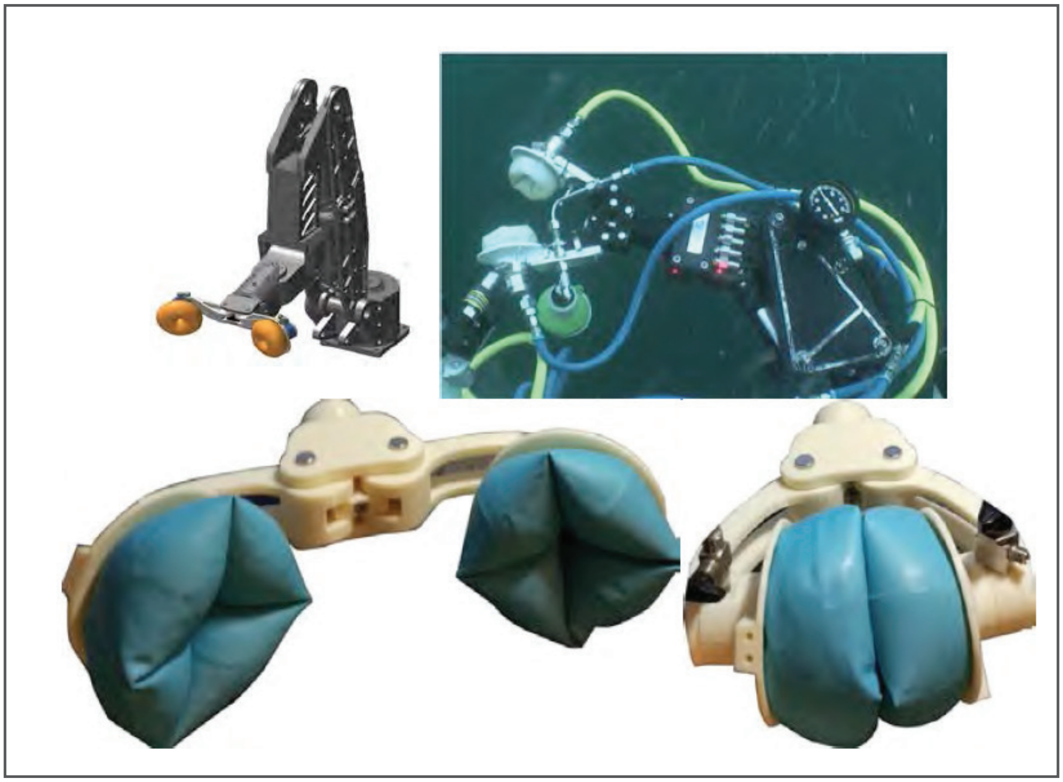
This project will generate transects of deep physical oceanography and hydrothermal plume activity along the ridge axis sufficient to identify seafloor vents to within one kilometer. This project will include an autonomous exploration to map hydrothermal activity along the 200-kilometer extent of the Gorda Ridge off the U.S. West Coast. Existing maps of venting along the Gorda Ridge will provide ground truth against which to validate the results. The work will include: building and installing one-way travel time inverted ultrashort baseline positioning (OWTT-iUSBL) units on two underwater Deepgliders and the associated acoustics on a Waveglider; installing on the gliders a suite of chemical sensors suited to the detection of hydrothermal effluent deploying the system; managing it from shore; and finally recovering all three vehicles. Vehicle coordination algorithms will also be developed to maintain acoustic contact among the robots during the survey. At the conclusion of the project, two Deepglider-compatible OWTT-iUSBL units will exist to enable future exploration and the OWTT-iUSBL system design and algorithms will also transfer to future multi-vehicle teams. Although the project focuses on hydrothermal exploration, the system will also enable infrastructure-free measurements of deep currents (by using OWTT-iUSBL position fixes similarly to how shallow gliders use GPS fixes today to estimate and average current between surfacings).

The multi-robot long-range exploration system envisioned in this proposal. A Waveglider automated surface vehicle (ASV) provides navigational aiding and mission updates to two submerged Seaglider autonomous underwater gliders (AUGs) performing high-resolution water column mapping. *Image courtesy of Michael V. Jakuba.*

Advances in deep-sea sampling with soft robotics

Stephen Licht—University of Rhode Island
Budget: $91,021
Dates: N/A

Soft robots and compliant manipulators have been shown to dramatically simplify the problem of grasping complex objects without exerting undue force on the object or its surroundings. As a result, robots are increasingly being used for gentle and precise grasping tasks. However, many of the compliant mechanisms that have been developed for use in air are pressure intolerant, unsuited for use in water, or unable to withstand repeated deployment and recovery at sea. The proposed effort will advance soft robotic manipulator systems technology suitable for selective sample recovery from sensitive cultural and biological sites, a key area of ocean exploration science. This project will demonstrate (a) a novel hybrid soft robotic gripper and (b) a next-generation drive mechanism that will enable the precise control of seawater hydraulics for soft manipulation and that are inherently safe, reliable, and robust for deepwater deployment.



Robotic gripper prototypes. Top left: Initial concept design shown mounted to the wrist joint of a Kraft Predator underwater seven degrees of freedom arm. Top right: Image of second generation prototype on a SeaEye remotely operated vehicle HydroLek arm. Bottom: Third generation prototype showing range of motion and potential membrane configuration. *Images courtesy of Stephen Licht.*