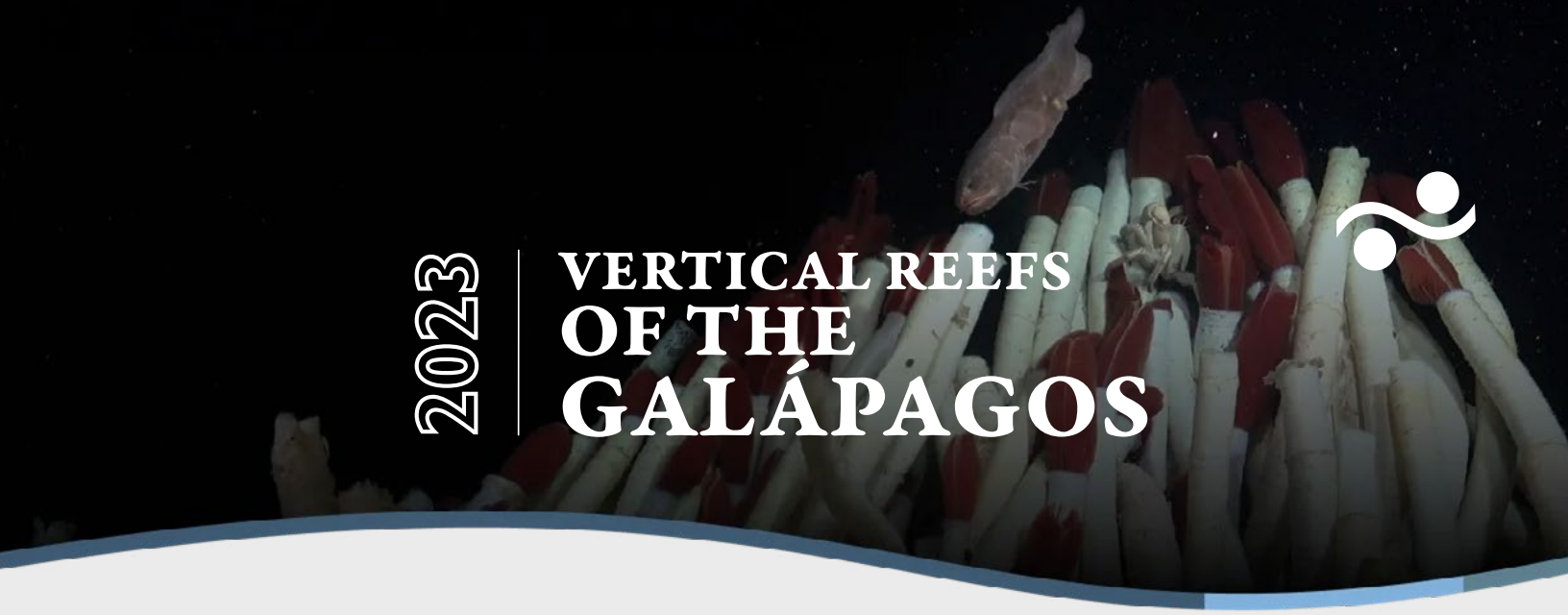


2023 | VERTICAL REEFS OF THE GALÁPAGOS

FKt230918 | #VerticalCliffs

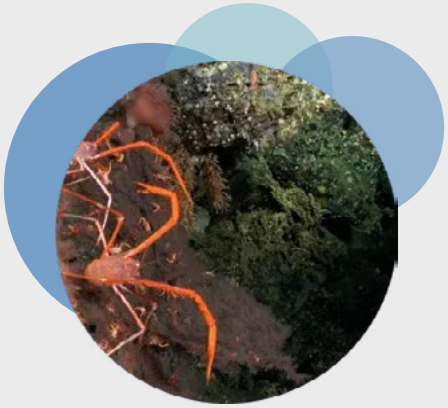
- Galápagos Islands National Park, Ecuador and Isla del Coco, Costa Rica
- 18 September - 19 October 2023
- Dr. Katleen Robert, Memorial University Newfoundland
- Ship Track

- **31** science days
- **31** terabytes of data collected
- **25** ROV dives
- **12,892** sq km mapped
- **105** CTD & rosette casts
- **337** samples

Expedition objectives:

- Establish the geological characteristics and formation of cliff environments in the Galápagos National Park — these are environments where existing marine protections and their vertical orientation prevent damage from trawling or other destructive activities.
- Establish a coral history, creating a baseline for past climatic conditions.
- Understand the links between environmental settings, such as the cliff orientation, water column dynamics, features of vertical coral reef surfaces, and cold-water coral community biodiversity.
- Create detailed, high-resolution maps of the study area to inform future research and protection.

The Galápagos Islands are home to a dazzling array of cold-water corals in an active geological environment, making the region ideal for this study. While they are understudied compared to shallow-water corals, a subset of these deep-dwelling animals is even more shrouded in mystery — cold-water corals living on cliffs. The depth and inaccessibility of vertical corals to ship-based sensors present significant hurdles to studying these creatures. Chief Scientist Dr. Katleen Robert and a multidisciplinary team addressed these challenges to map and characterize these extraordinary habitats.



The science team discovered thriving cold-water coral reefs with a high biodiversity of associated organisms in a marine protected area with little deep-sea scientific information. Two major currents, the cold South Equatorial Current and the warmer Panama Current, flow around them while the Pacific Equatorial Undercurrent interacts directly with the islands. In addition to oceanographic patterns, the Galápagos also provides a valuable laboratory for studying island geology. The islands are built on pedestals of stacked lava flows — some of which are exposed, offering a stratified geological history of the archipelago. The oceanographic complexity of the region plays an essential role in understanding past and future climatic conditions.

Further, the Galápagos National Park is a longstanding protected area with little human impact, and therefore, its cliff-dwelling coral reefs represent ecosystems in near-pristine conditions. These healthy conditions allow for observing natural patterns and establishing ecological baselines, often missing from well-studied but more impacted coral systems, such as those in the North Atlantic.

In addition to investigating coral biodiversity in the Galápagos, the scientists explored areas within the Isla del Coco National Marine Park, a protected area managed by Costa Rica, to examine links between coral communities on seamounts in the Galápagos and those in Costa Rica. The data collected will inform the management of the Eastern Tropical Pacific Marine Corridor, a network of interconnected marine reserves managed by the governments of Ecuador, Costa Rica, Panama, and Colombia.

The team deployed several advanced technologies, including ultra-high-resolution laser scanning, which has not been widely applied in studying these communities. These tools will help researchers create a three-dimensional reconstruction of cliff reefs. Shipboard multibeam echosounders provide a smooth representation of rough

topography, creating maps with approximately 50- to 100-meter resolution. They cannot adequately characterize the vertical dimension of complex 3D seafloor structures. Using an ROV-mounted multibeam system and laser scanner in tandem, the researchers created a bathymetric map and a point cloud of data rather than visual imagery; this can achieve a resolution of fewer than two millimeters and develop a detailed portrait of the vertical environment, revealing both geological and biological components.

Following the expedition, the team is working to create an accessible, digital reconstruction of the cliff-dwelling coral ecosystems — a data visualization that allows everyone, from scientists to second-graders, to visit the deep sea. The data collected adds to human knowledge of the distribution of cold-water corals globally.

Resulting highlights include:

- Observed thriving cold-water coral reefs teeming with anemones, crustaceans, cephalopods, and other organisms in an understudied ocean region.
- Provided key insights into the effectiveness of a long-established marine protected area; the Galápagos Marine Reserve data supports the management of two local marine protected areas — Galápagos National Park and Isla del Coco National Park.
- Used ultra-high-resolution laser scanning, which has not been widely applied in studying these communities, to create a detailed 3D reconstruction of the reef habitats, laying the foundation for connecting environmental conditions to habitat complexity, community composition, and biodiversity.

Permits to conduct research in Ecuador and Galapagos Islands National Park waters: DIRNEA - SNA - 2023-001-O / PNG MAATE-DPNG/DGA-2023-1174-O / PC-51-23 / R-045-2023-OT-CONAGEBIO