

# GEOMAR's Contribution to Deep-Sea Ecosystem Discovery and Management



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**Introduction:** The **GEOMAR-led SO294 expedition** to the northern Cascadia Margin has advanced the **understanding** and **management** of deep-sea ecosystems by uncovering previously undocumented cold seep habitats along Canada's Pacific margin. Cold seeps are geochemically active zones where hydrocarbon-rich fluids (primarily methane) bubble out of the seafloor. Cold seep ecosystems in Pacific Canada have been historically overlooked, but a significant shift occurred in 2018 when they were formally recognized as **Ecologically and Biologically Significant Areas** (DFO 2018). With increased interest and research, this area is now under consideration for further **management and conservation** by Canadian & Indigenous governments in alignment with the commitments made to the United Nations Ocean Decade and the target of achieving 30% ocean protection by 2030.

## GeoMAR Mapping

Through the collection of high-resolution bathymetry and water column data, the GEOMAR-led SO294 expedition identified promising indicators of active cold seeps, significantly increasing the observations of gas plumes in the area.

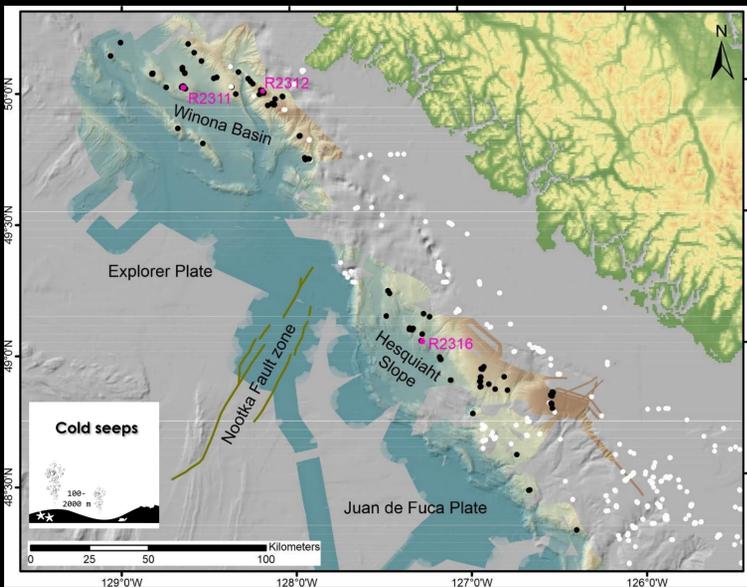


Figure 1. Map with updated multibeam & mapped gas plumes detected off Vancouver Island (white: Riedel et al., 2018; black: newly mapped by SO294). Two locations with prominent gas seeps in the Winona Basin and on the Hesquiaht Slope were investigated with the ROV ROPOS in 2023.

## Local Collaboration

These discoveries catalyzed targeted dives with a remotely operated vehicle (ROV; Canadian Scientific Submersible Facility ROPOS) during a Northeast Pacific Deep-Sea Exploration Project (NEPDEP) expedition in 2023 by Canadian and coastal First Nations scientists.

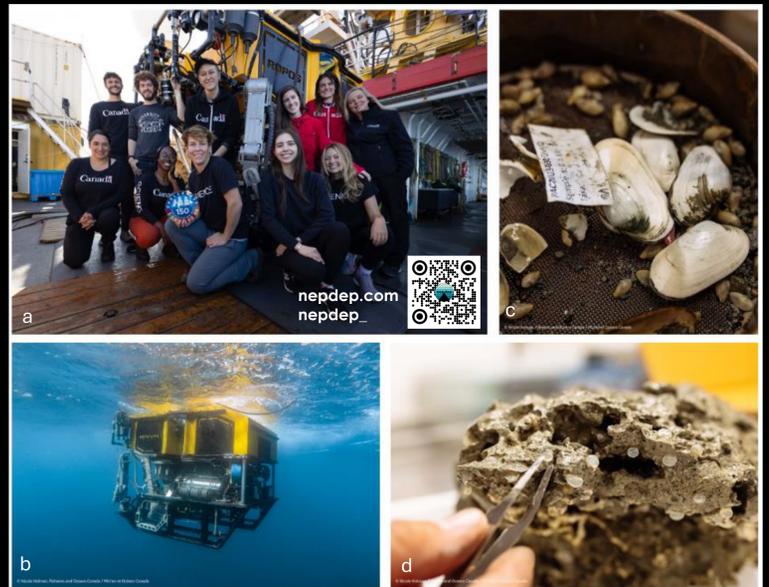


Figure 2. The 2023 NEPDEP expedition featuring a) The at-sea crew, b) ROV ROPOS, c) biological samples of the chemosynthetic community and d) biological samples being pulled off of a geological sample of carbonate rock.



Figure 3. Example imagery of the extensive carbonate ridge (at least 500m high by 25 km long) and its inhabitants along the Winona Ridge.

## Ecosystem Discoveries

The ROV dives have led to the discovery of diverse cold seep ecosystems that include extensive carbonate ridges (Figure 3) and massive gas hydrate mounds (Figure 4). Visual exploration of the sites at two of the most significant gas plume signatures (visible in echosounder almost to the surface) found extensive bathymetric features and gas hydrates on the seabed (Figure 4). The imagery & data demonstrates that cold seeps are far from rare and isolated patchy sites but instead are often extensive and complex seafloor features that shape surrounding marine ecosystems.

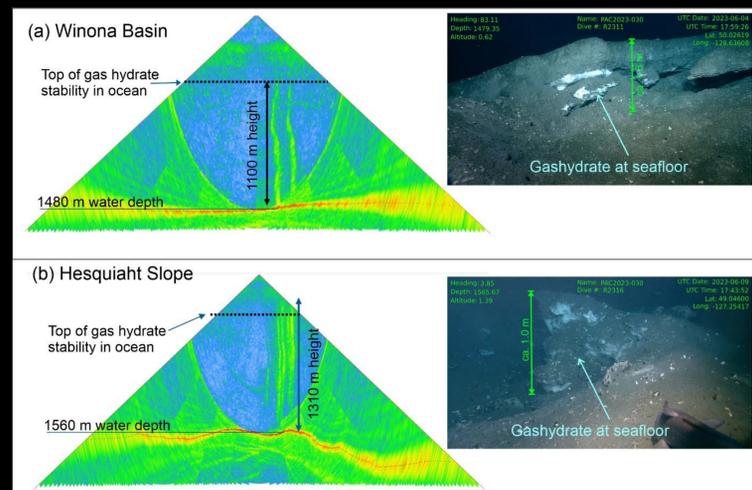


Figure 4. Two significant sites showing water column acoustic data from the echosounder (EM122; left) and ROV ROPOS images of the gas hydrate deposits on the seabed (right). a) Winona Basin, dive R2311 & b) Hesquiaht Slope, dive R2316.

## Engagement for Change

This GEOMAR-led SO294 collaboration with NEPDEP has led to the identification of key ecosystem services provided by these cold seeps: their role in deep-sea primary production (chemosynthesis), essential fish habitat for commercial species, nursery grounds for Deep-Sea Octopuses, and stable hard substrates that support diverse communities of deep-sea species including corals and sponges.

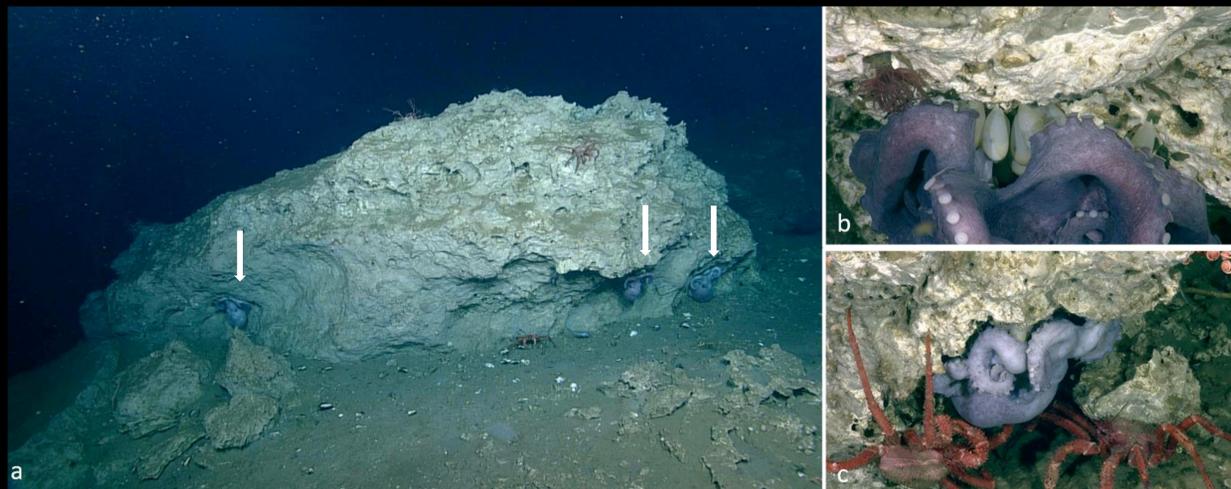


Figure 5. Deep-Sea Octopus Nursery (*Graneledone pacifica*) observed at Hesquiaht Slopes a) three mothers (arrows) in view on underside of boulder, b) egg attachment and care on a carbonate boulder and c) protection provided to these eggs over 4.5 years.

The stunning imagery of the extent of the ecosystems at cold seeps in the Cascadia basin has captured the attention of global audiences, scientists, and policy makers. The GEOMAR expedition provided foundational data that has directly contributed to Canadian and First Nations marine conservation science, informed policy decisions, and strengthened stewardship of these vital ecosystems.