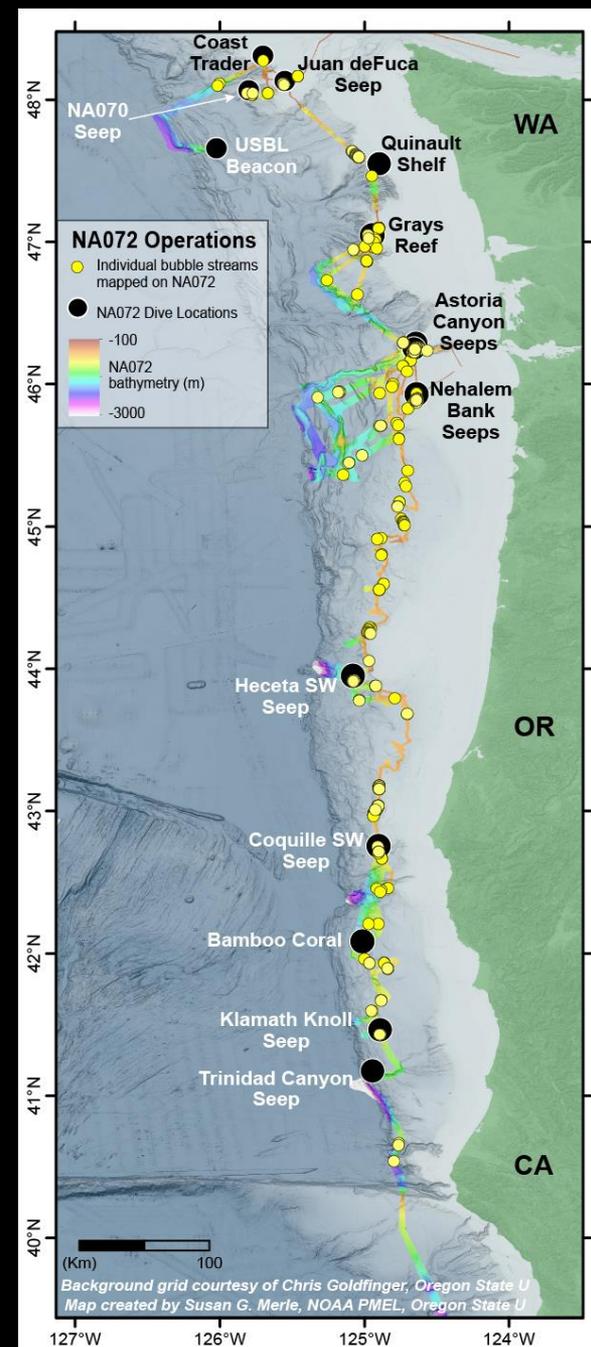


E/V Nautilus 072: Seeps and Ecosystems of the U. S. Cascadia Margin

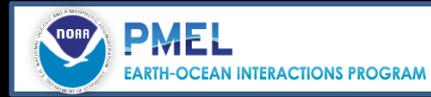
- Cruise Dates:** June 1-20, 2016
- Lead Scientists:** Dr. Robert Embley, NOAA PMEL (at sea)
Dr. Stephen Hammond, NOAA PMEL Affiliate, (ashore)
- Expedition Leader:** Dr. Nicole Raineault, Ocean Exploration Trust Inc.
- Ashore Participation:** Robust participants via chatlog by Academia and NOAA Line Organizations
- Main Operations:** ROV *Hercules*, ROV *Argus*, EM302 multibeam and water column mapping, sub-bottom profiling



Seeps and Ecosystems of the Cascadia Margin

Principal Partners:

- Pacific Marine Environmental Laboratory (NOAA) – Methane seep mapping & gas sampling, acoustics



- Olympic Coast National Marine Sanctuary (NOAA) – Quinault Canyon ground truthing of *NOAA Ship Rainier* multibeam survey



- NW and SW Fisheries Science Centers (NOAA) – Grays sponge reef and Bamboo Coral sites (southern Cascadia)



- National Marine Sanctuaries Marine Heritage program – Coast Trader



- University of Washington – seeps



- Oregon State University - seeps



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Seeps and Ecosystems of the Cascadia Margin

Motivations

- A huge volumes of methane is stored in hydrate (ice-like solid phase) & within sediments of the continental margins
- Methane is a powerful greenhouse gas
- Although methane is always fluxing into the oceans through faulting and other processes, the advent of rapid ocean warming could, in the future, release large volumes at the upper limit of the methane hydrate stability zone
- Some recent work has suggested hydrate destabilization has already begun in the NE Pacific (at upper limit of stability zone ~500 m)
- Multibeam technology now enables rapid mapping of methane Plumes. Most discoveries in past have been serendipitous
- How important is the methane seep habitat

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Seeps and Ecosystems of the Cascadia Margin

Objectives for methane seep cruise theme:

- **General theme – Establish better baseline characterization & distribution of methane seeps along Cascadia**
- **Obtain gas samples (retained at in situ pressure) of bubble plumes where possible (CH₄, CO₂, He and other noble gases)**
- **Obtain samples suites of push cores, carbonates and macrobiology at dive sites**
- **Deploy hydrophone at sites to obtain acoustic signature of bubble streams**

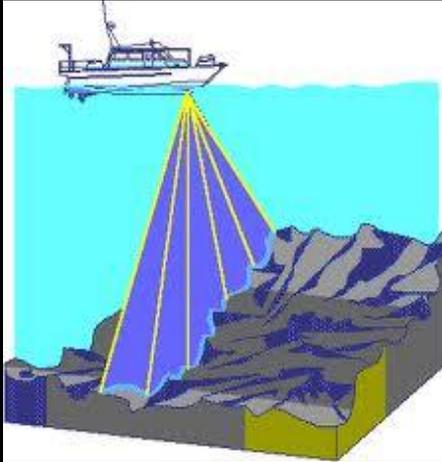
<http://www.pmel.noaa.gov/eoi/pdfs/2016-PacificCoast-NA072-CruiseReport-hires.pdf>

<http://www.pmel.noaa.gov/eoi/pdfs/2016-PacificCoast-NA072-CruiseReport-lores.pdf>

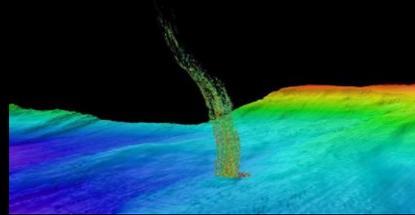
NA072 Technology

E/V Nautilus

Seafloor Swath 3-3.5 x water depth



Water Column Plume



Telepresence

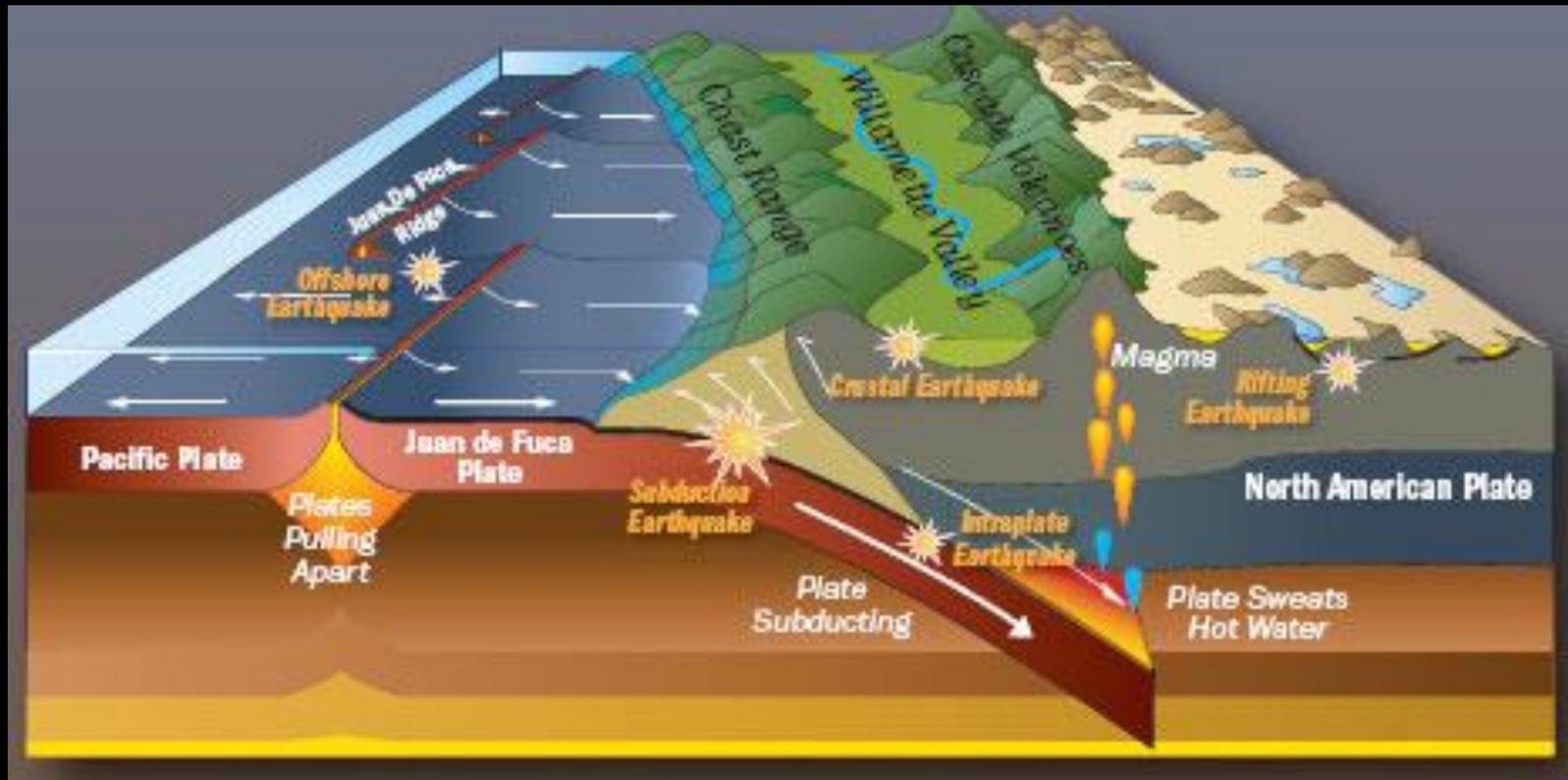


ROV Hercules/Argo

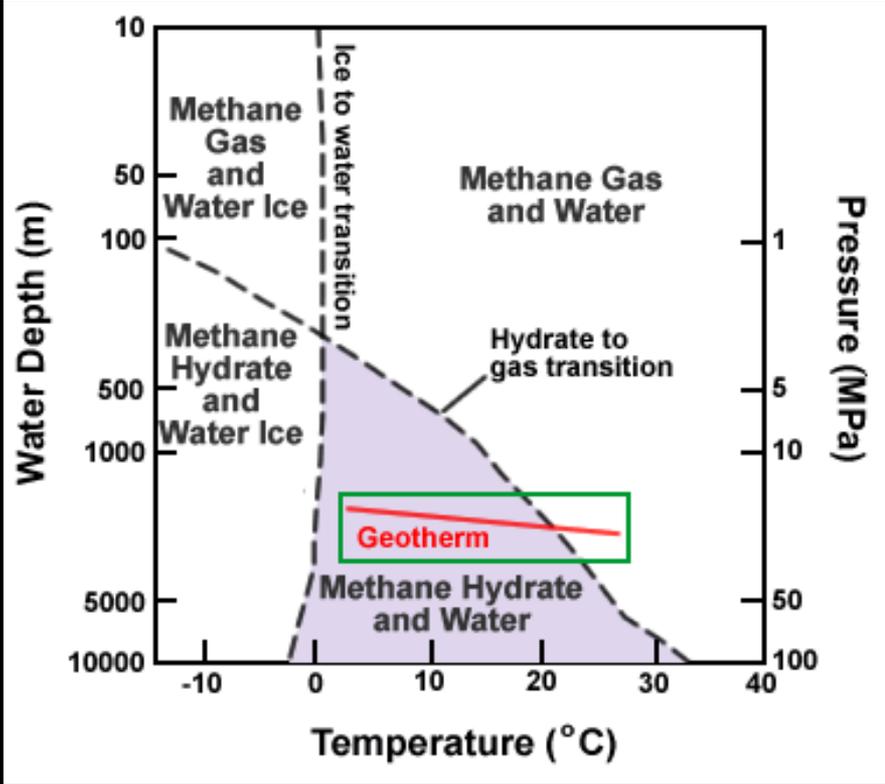
- Hydraulic with 2 manipulators
- HD video on both vehicles
- Push cores, biobox
- Niskin bottles
- CTD
- Temperature probe



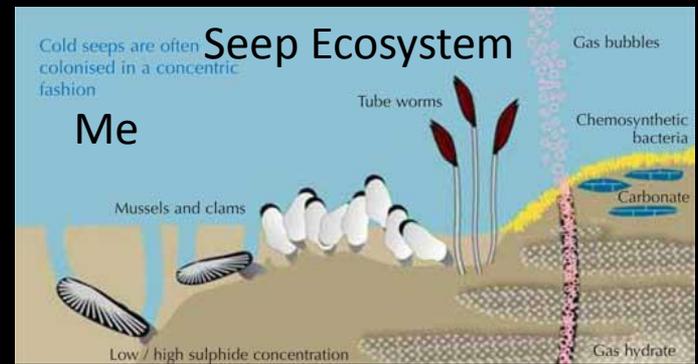
**Water column survey with EM302
along 500 m contour – Coquille
Bank, S. Oregon margin**



- The Cascadia continental margin is a plate boundary, where the Juan de Fuca plate is being subducted beneath the North American Plate
- This creates a strong tectonic overprint on the margin as sediment is accreted from the ocean plate

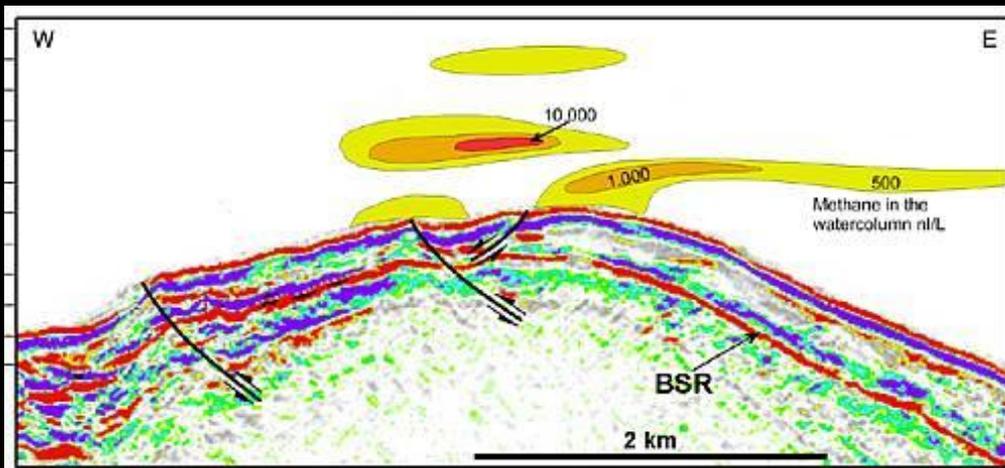


BSR <http://geology.com/articles/methane-hydrates/>



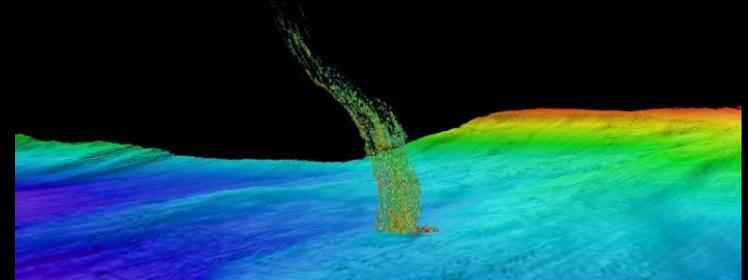
www.scienceinschool.org/201v0/issue16/coldseeps

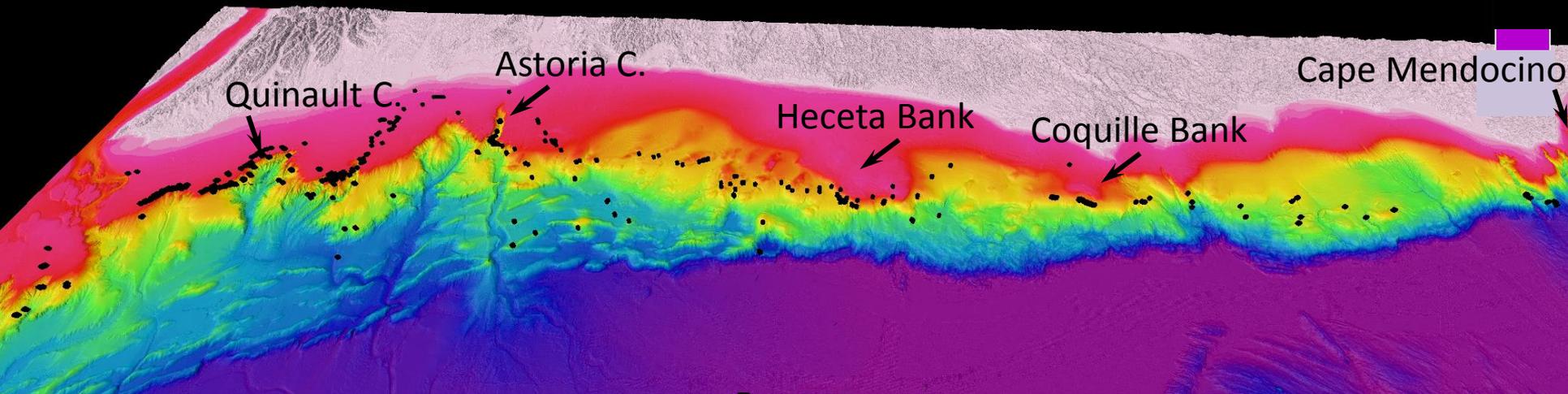
Methane seeps along Cascadia occur where fault/canyons/slumps breach the hydrate layer or at the upper limit of hydrate stability (~500 m on the cascadia margin)



<https://sfb574.geomar.de/theme-b.html>

Water Column Plume

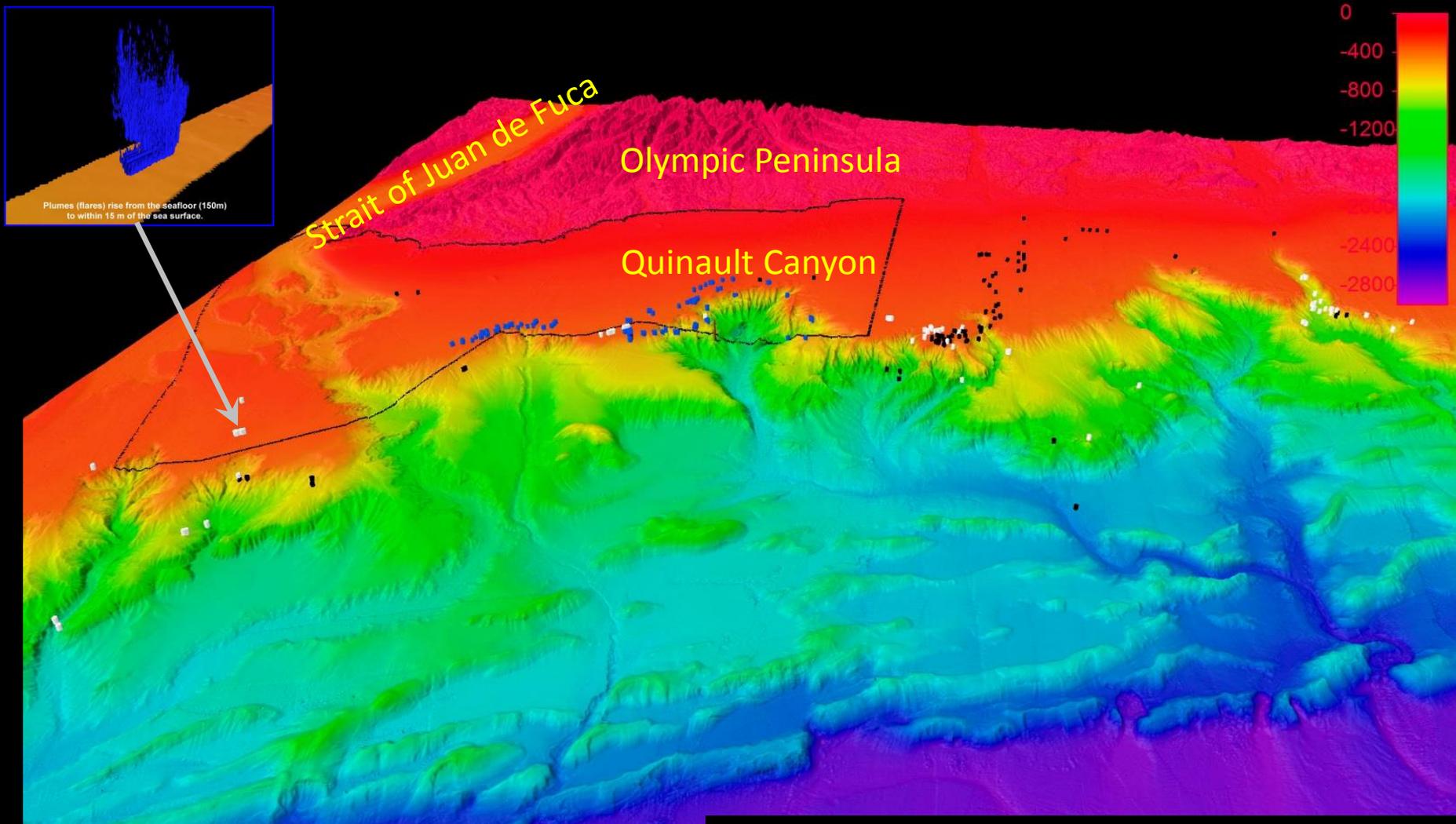




~ 850 nautical miles (1560 km)

- As of September 2016 there are over 500 bubble plume sites along the Cascadia margin (~15% not on this map – discovered in early September)
- After grouping by separation distance (<300 m) there remains more than 200 sites with single or multiple bubble plumes

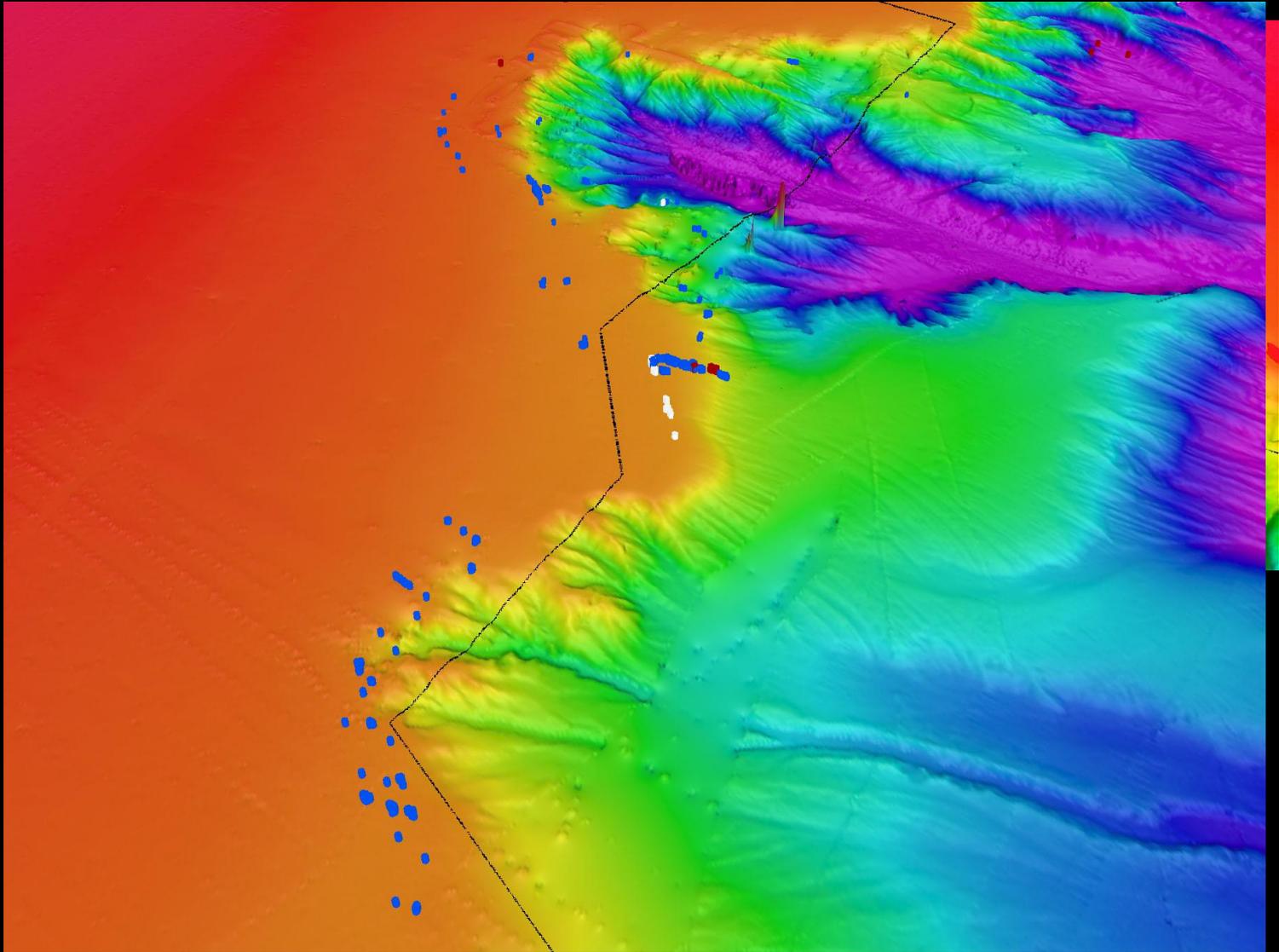
Seeps within the OCNMS – Juan de Fuca seeps



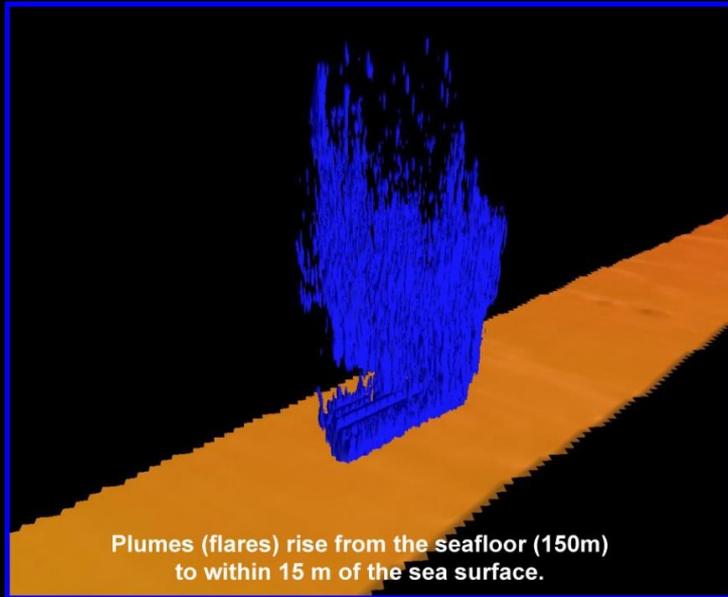
Black dots— Johnson et al., 2014, historic
Blue dots – NOAA Ship *Rainier* (OCNMS), 2015
White dots – *E/V Nautilus*, 2015

Seeps within the OCNMS – Quinault and Quillayute Canyons

(Combination of historic, *Rainier* 2016 and *Nautilus* 2016)



Juan de Fuca Seeps – In OCNMS (~125 m) Up to the interface

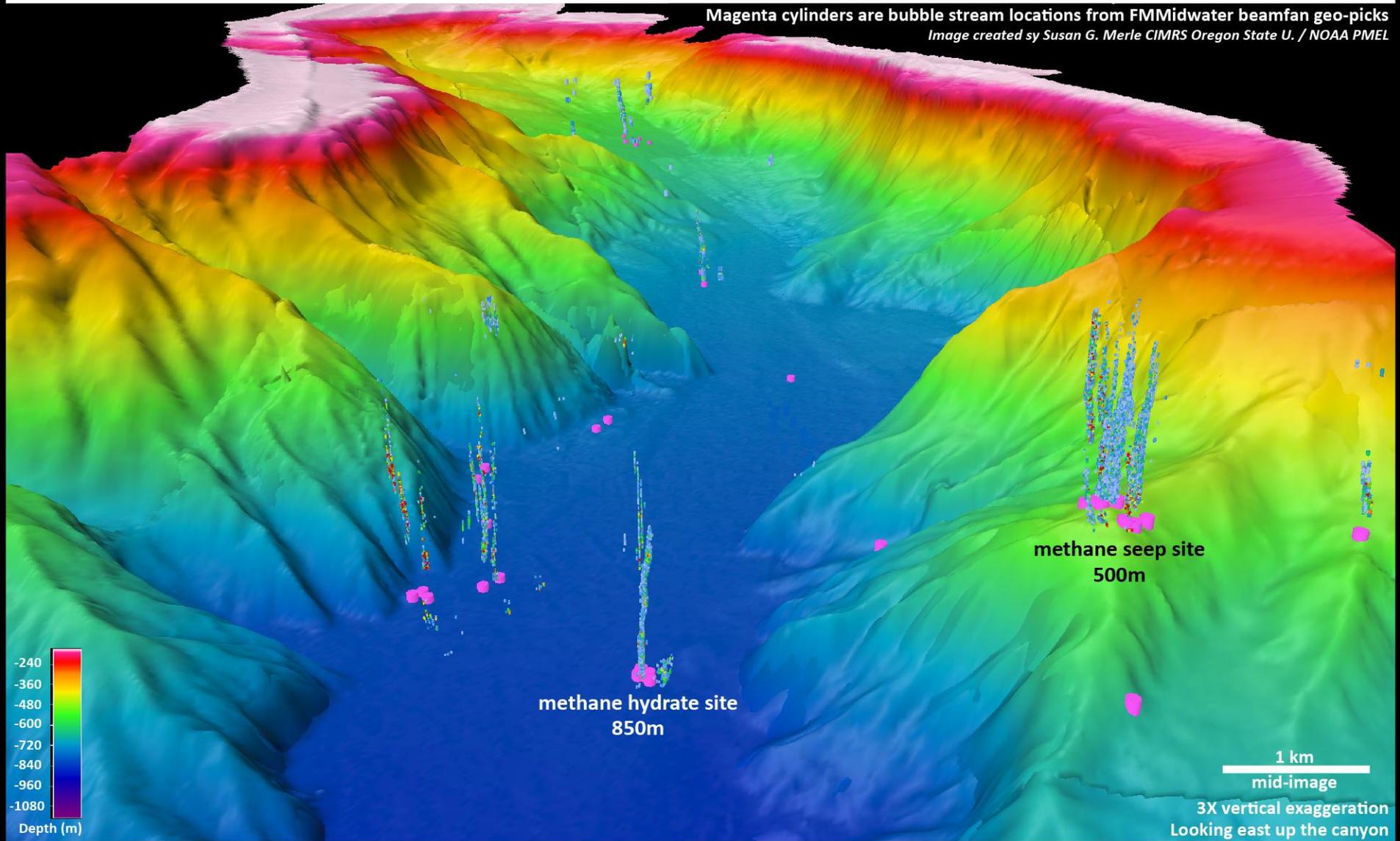




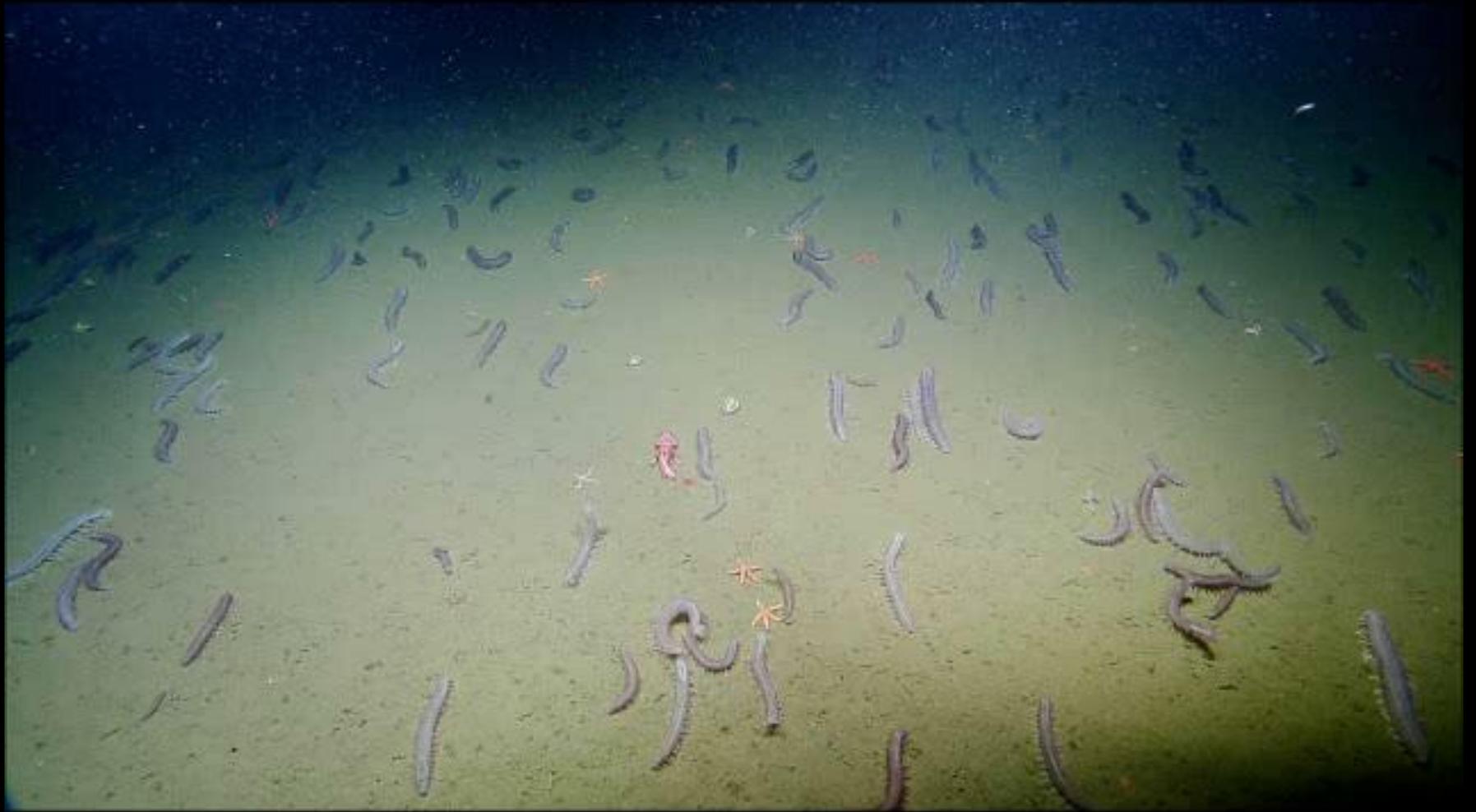
Astoria Canyon Methane Bubble Streams

Magenta cylinders are bubble stream locations from FMMidwater beamfan geo-picks

Image created by Susan G. Merle CIMRS Oregon State U. / NOAA PMEL



Astoria Canyon Floor - Beasty feasty!

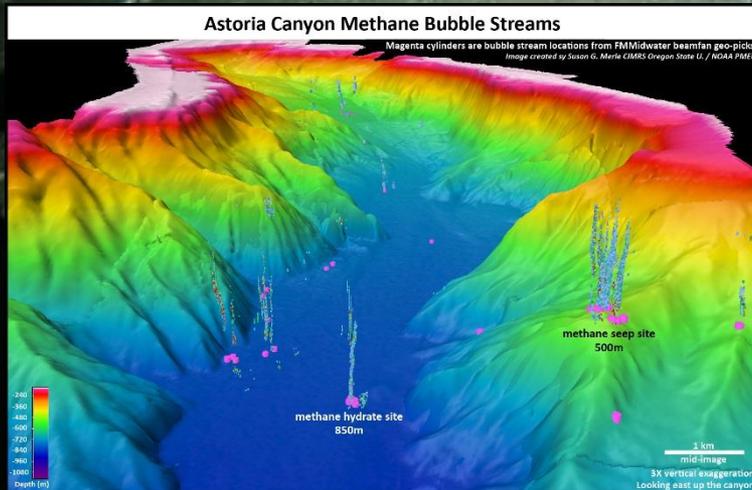


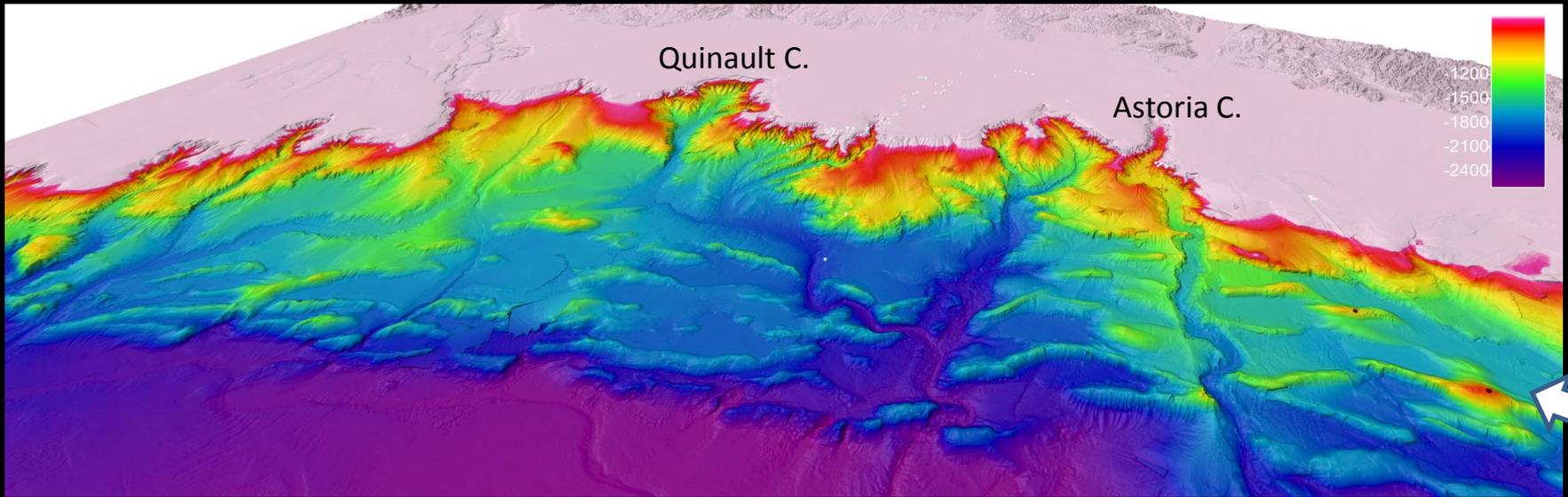
Astoria Canyon Floor (850 m)

Ice and Bubbles

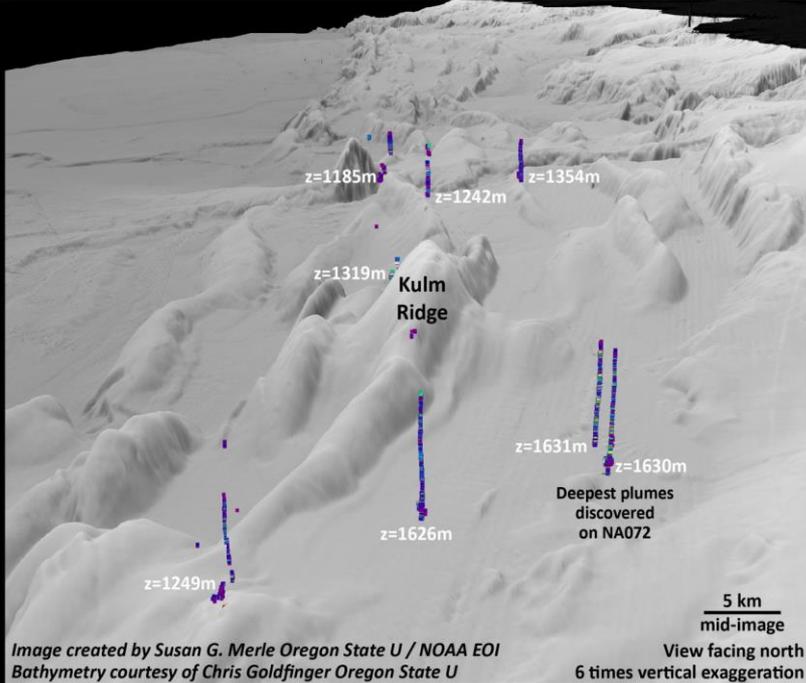


South wall Astoria Canyon (500 m) Fisherman's Delight

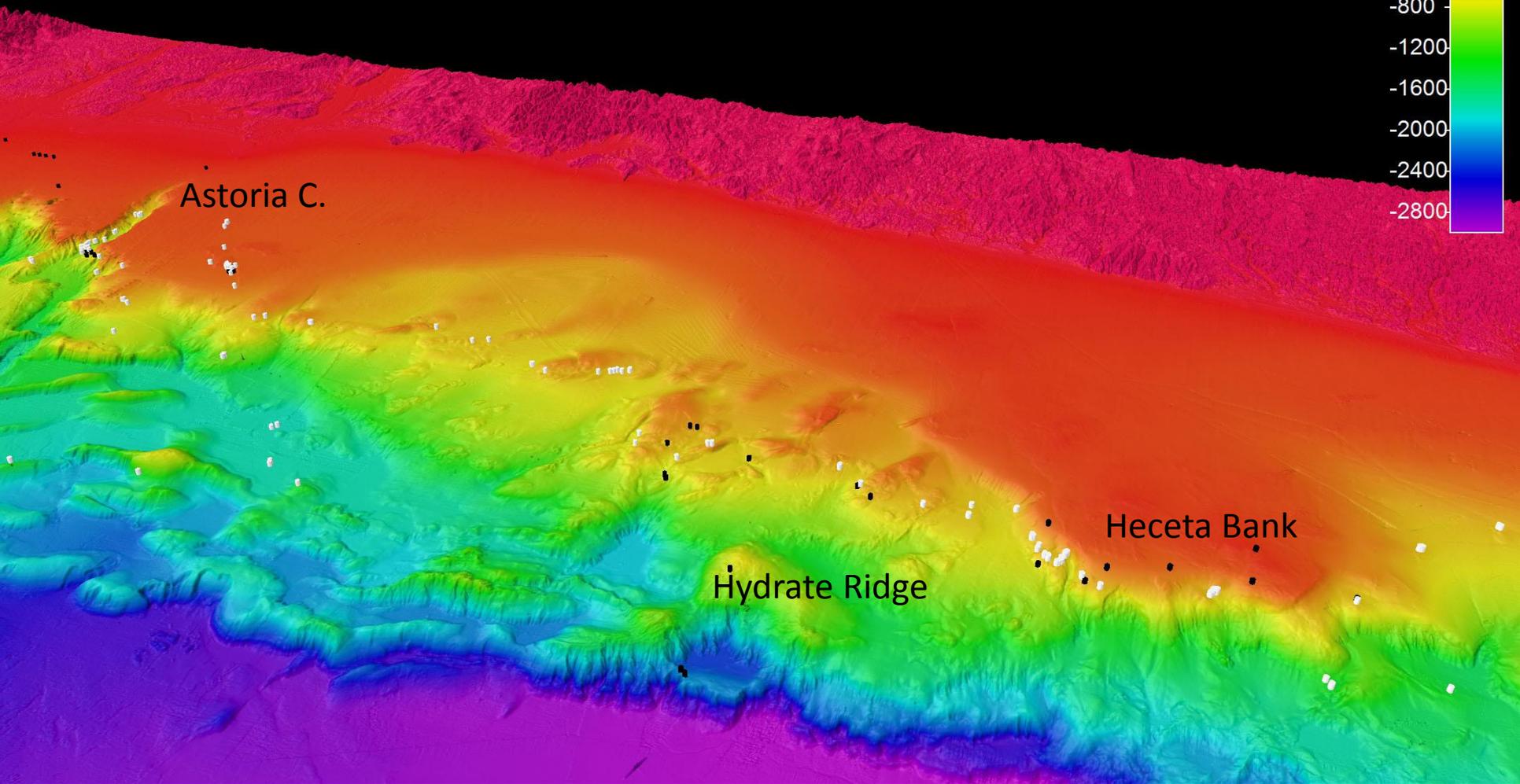




Deep bubble streams in the area of Kulm Ridge, offshore Oregon

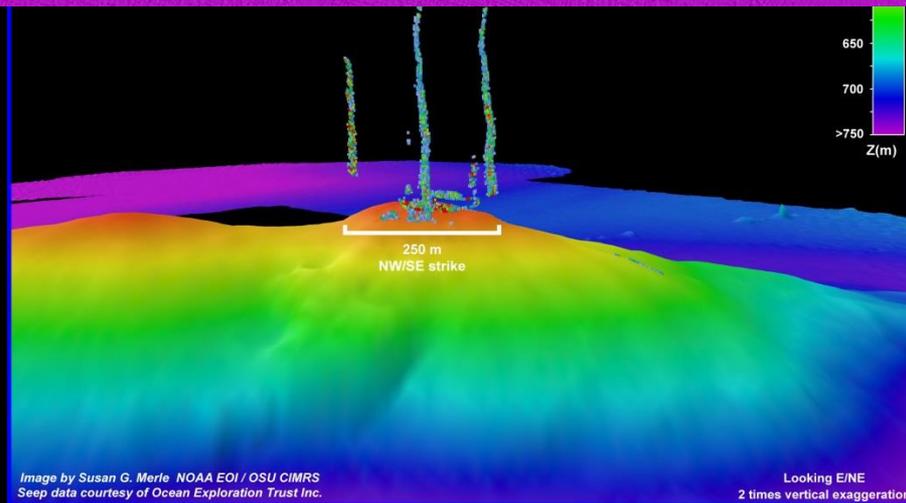
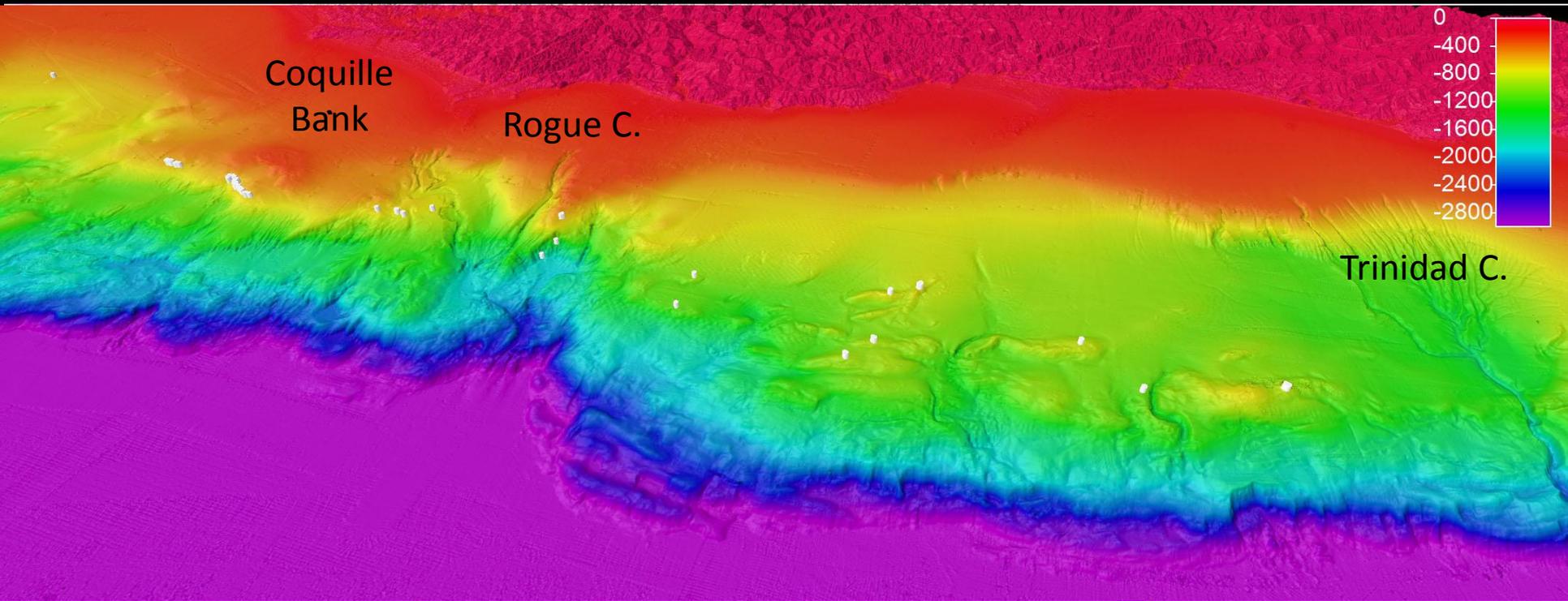


Northern Oregon



Black dots— Johnson et al., 2014, historic
White dots — *E/V Nautilus*, 2015

Southern Oregon-Northern California



SW Coquille Bank (615 m) What lies beneath





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Conclusions:

- ***Hundreds of new bubble plume location In water depths ranging from 125 to 1630 m***
- ***Nine locations characterized by Hercules ROV***
- ***A later cruise (Nautilus 078) in September found an additional >50 bubble plumes S. Oregon/N. Calif. margin***
- ***The large number of active sites being discovered with the multibeam sonar systems and the large areas of associated carbonate upgrades the importance of the seep as a deep-sea habitat***