ROV Dive Summary
EX2304, Dive 04, July 18, 2023

General Location Map

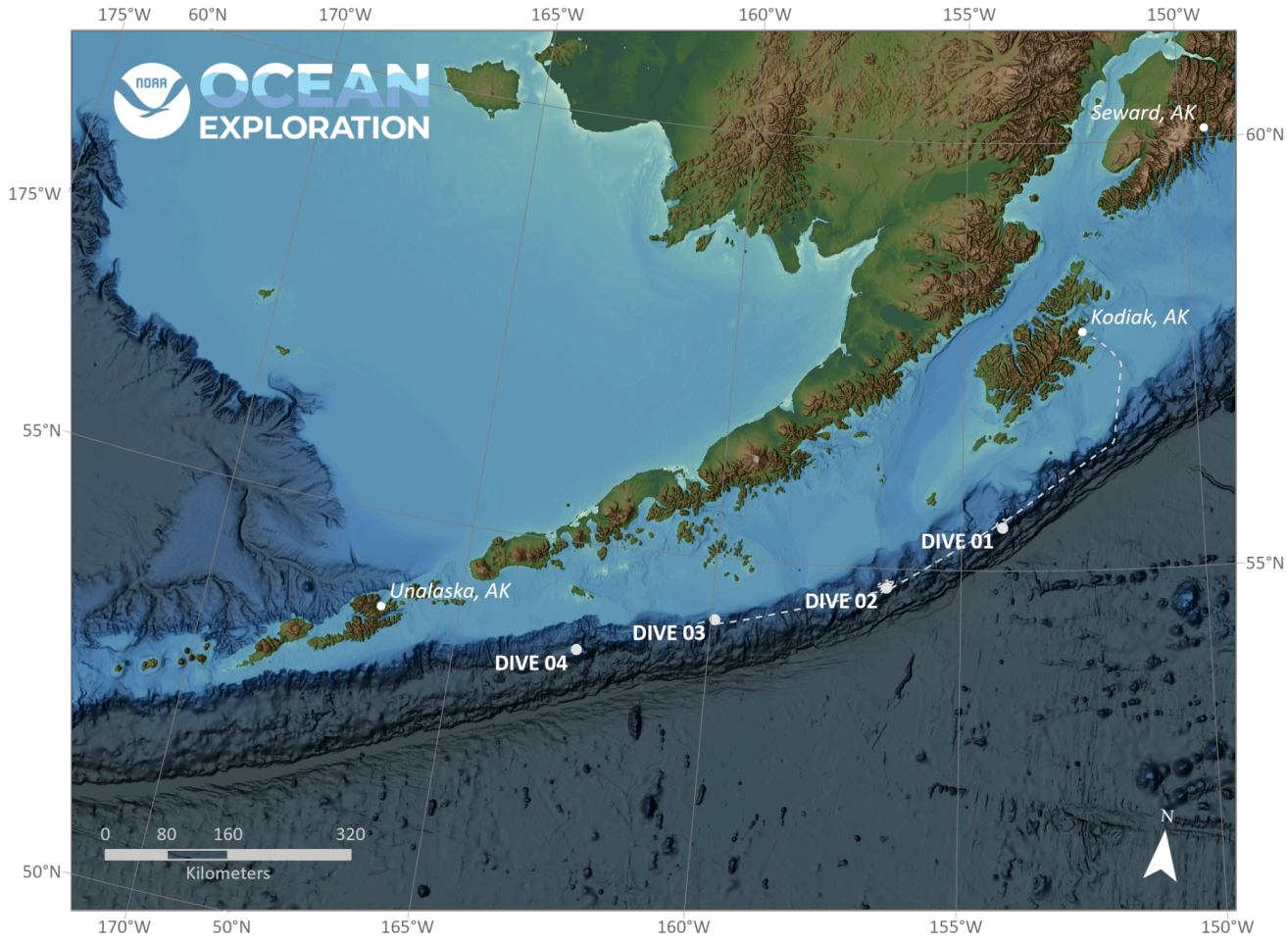


Figure 1. General location of EX2304 Dive 04.

Dive Information

Site Name	Dive 04: Sanak Seep
General Area Descriptor	43 mi (70 km) SW of Sanak Island on a structured portion of the continental slope
Science Team Leads	Rhian Waller (Bio); Jennifer Aschoff (Geo)
Expedition Coordinator	Shannon Hoy
ROV Dive Supervisor	Christopher Ritter
Sample Data Manager	Anna Lienesch; Jennifer Green
Dive Purpose	Biology, geology, eDNA
Maritime Heritage Restrictions	No

ROV Dive Summary Data	Dive Summary: EX2304_DIVE04 ^^ Dive Type: Normal In Water: 2023-07-18T16:59:21.747366 53.7482244627968 ; -162.582300531558 On Bottom: 2023-07-18T18:53:49.969895 53.74865745652128 ; -162.58824908730594 Off Bottom: 2023-07-18T23:23:51.906327 53.7478704599976 ; -162.586913715005 Out Water: 2023-07-19T02:47:30.252510 53.74969918183018 ; -162.6101223630005 Dive Duration: 9:48:08 Bottom Time: 4:30:01 Max Vehicle Depth: 2030.7 m Min Seafloor Depth: 2016.3 m Distance Travelled: 459.5 m **Mid Water Transects Summary** ^^ Number of Transects: 5 **Transect 1** Start: 23:36:04 53.7478037613735 ; -162.58666877061586 End: 23:56:01 53.747631093543454 ; -162.58467549128267 Duration: 0:19:56 Depth: 1965.0 m **Transect 2** Start: 00:42:11 53.74761435712388 ; -162.58416146431418 End: 00:52:03 53.74756394877041 ; -162.58412044740422 Duration: 0:09:51 Depth: 901.0 m **Transect 3** Start: 01:07:06 53.74765720515991 ; -162.58404621523243 End: 01:17:09 53.74764167524543 ; -162.58412675643407 Duration: 0:10:02 Depth: 701.0 m

	Transect 4 Start: 01:32:32 53.747656478266734 ; -162.58401873293352 End: 01:43:18 53.74752663964021 ; -162.5851913603598 Duration: 0:10:45 Depth: 501.0 m **Transect 5** Start: 01:57:12 53.747067843494506 ; -162.588083686989 End: 02:08:35 53.74670254587582 ; -162.5912668897121 Duration: 0:11:23 Depth: 301.0 m

Dive Description	***Geology*:** This dive targeted a linear array of cold methane seeps trending parallel to a ridge located between 2025-2015 m water depth. The seeps were observed along a 220 m long transect following the trend of a nearby fault. Four active seeps were observed emitting bubbles (methane based on bubble shape and sonar data). Other active seeps were suspected, but were likely buried in numerous, dense clusters of tubeworms. In one case, methane bubbles were observed coming through a thick cluster of tube worms suggesting an active seep below it. Three areas also contained exposed methane hydrate, a translucent white, smooth ice-like substance. Each hydrate exposure had different morphologies: 1) a thick (>20 cm thick) massive hydrate exposure with mushroom-like features, 2) a thinner, more delicate agglomeration of hydrate, and 3) a thin-veneered hydrate with a more mamalary morphology that was attached to a carbonate overhang. Several outcrops of authigenic carbonate were present. Additionally, hydrates were observed forming on the underside of worm-tubes as agglomerated hydrate bubbles. Methane-derived authigenic carbonate (MDAC) was found in multiple locations on the seafloor. This MDAC was locally coated in a dark material, likely a bacterial mat. In several locations there were rounded cobbles and pebbles present both on the seafloor and cemented within the MCAC. These pebbles are possibly glacial-derived clasts from glaciers that were once perched at the continental shelf margin ~26 Ky (Kaufman and Manley, 2004; Kaufman et al., 2011). ***Biology:*** This dive was dominated with >200m long dense "fields" of Lamellibranchia sp. tube worms (two collected - EX2304_D04_03B and 06B) and vesicomyid (likely Calyptogena sp.) clams, all covered in numerous associated species. Beneath the patches appeared to be pavement of agglutinated tube worms often covered in bacterial mats that were either orange (some collected - EX2304_D04_02B)) or grey. Numerous lithodid crabs were seen around the site, including a cluster of six small/juveniles preying on a clam/mussel. There were also at least two species of limpets observed and collected as associates, as well as several species of gastropod, numerous associated worm species, and dense clusters of anemones around areas of bubbling gasses. Numerous fish were also observed including eelpouts, grenadier and several giant blob sculpins. Around the edges of the field were dead tubes and clam shells, indicating that the site was nearby. Also of note were Acharax mussel shells that appeared to be empty, though some live ones may have been deeper in the sediments. In all this site may be characterized by a high biodiversity site, as many more species are likely to be found with further investigations. Despite being an area of productivity, the second half of the dive in the water column, directly above the seep, was less productive than Dive 01 of this cruise (though it should be noted that transects were significantly shorter). This midwater dive saw a bloom of lobate ctenophores (Bolinopsis), Aeginura grimaldi red jellyfish and numerous siphonophores, dinner plate jellies (Solismius) Poralia and Ctenocerus cidipid ctenophores.

	All five eDNA niskin samples were taken during this dive - one in the deep scattering layer, one at the seeps, one on the midwater BBL transect, then at 900m and 700m respectively.
Notable Observations	In-situ gas hydrates with methane-derived authigenic carbonate. At least 200m long, dense vestimentiferan worm fields.
Community and Habitat Observations	Corals and Sponges — Absent Chemosynthetic Community —Present High biodiversity Community — Present Active Seep or Vent —Present (cold methane seep) Extinct Seep or Vent — Absent Hydrates — Present
CMECS Feature Type(s)	Authigenic carbonate, rock outcrop
SeaTube Link (science annotations)	https://data.oceannetworks.ca/app/dive-logs/6580

Equipment Deployed

ROV	*Deep Discoverer*
Camera Platform	*Seirios*
ROV Measurements	The following ROV measurements, data streams and equipment are used on each ROV deployment: CTD, depth, scanning sonar, USBL position, altitude, heading, attitude, high-resolution cameras, low resolution cameras, manipulator arms, suction sampler, sample drawers and thrusters. The following row notes if any of these sensors were malfunctioning or not operational.
Equipment Malfunctions	

Dive Site Overview Images

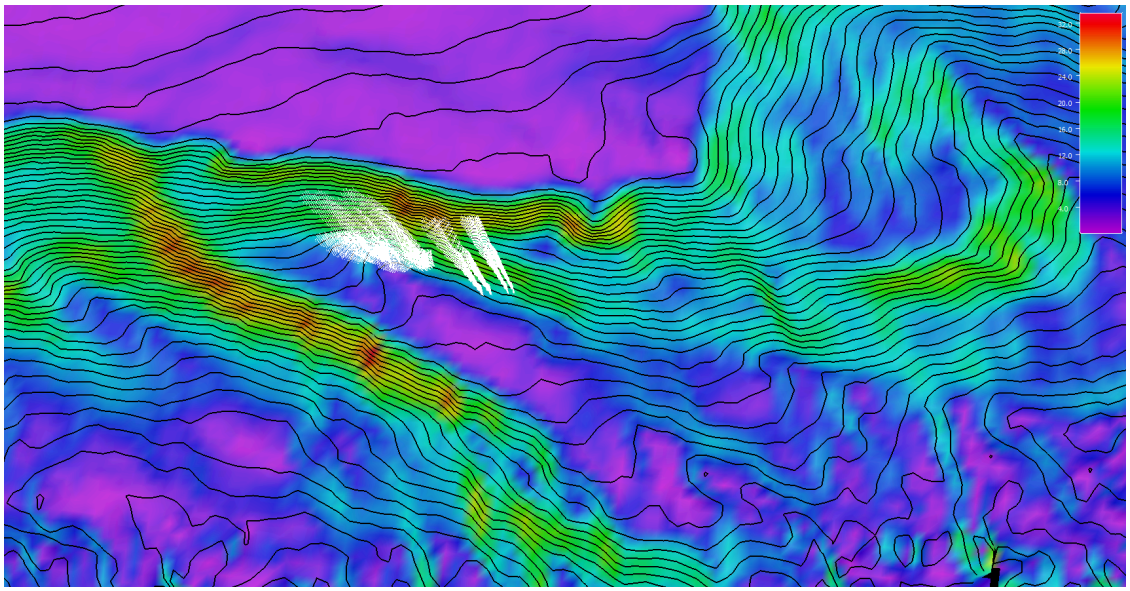


Figure 2. Overview of Sanak Seep bathymetry showing the location of the seeps (white). Depths in meters.

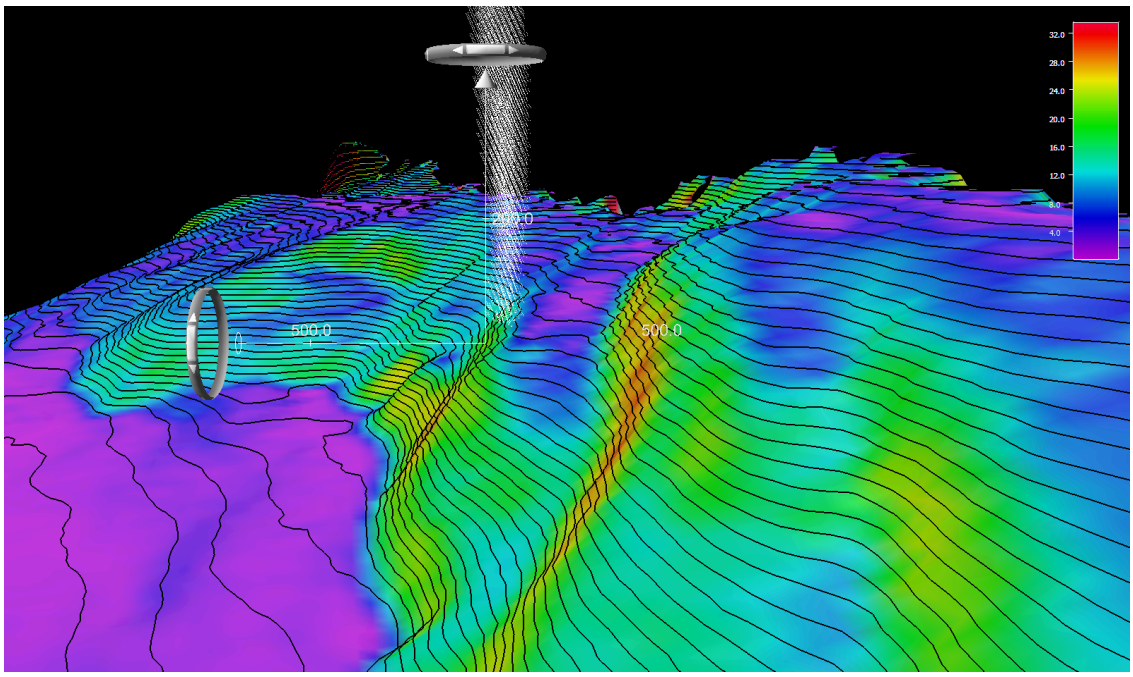


Figure 3. Overview of Sanak Seep array showing 3 possible fault blocks with the line of seeps positioned on the seaward most fault line. Depths in meters.

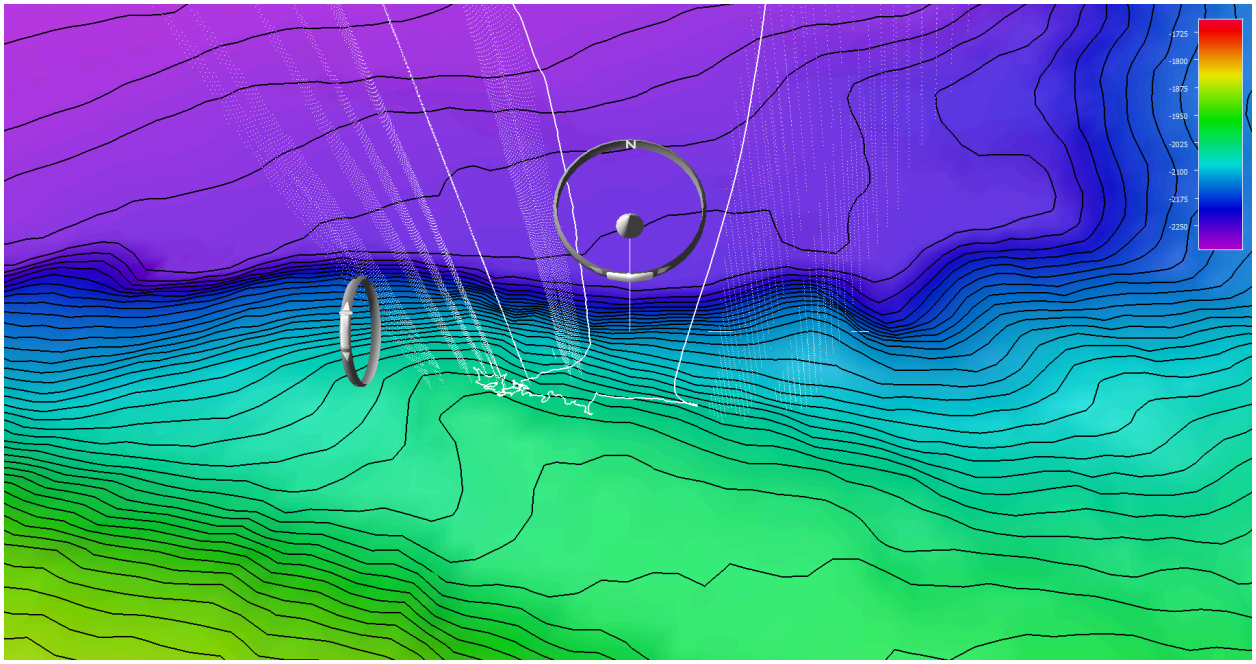


Figure 4. Overview of Sanak Seep showing the ROV track as dove. Depths in meters.

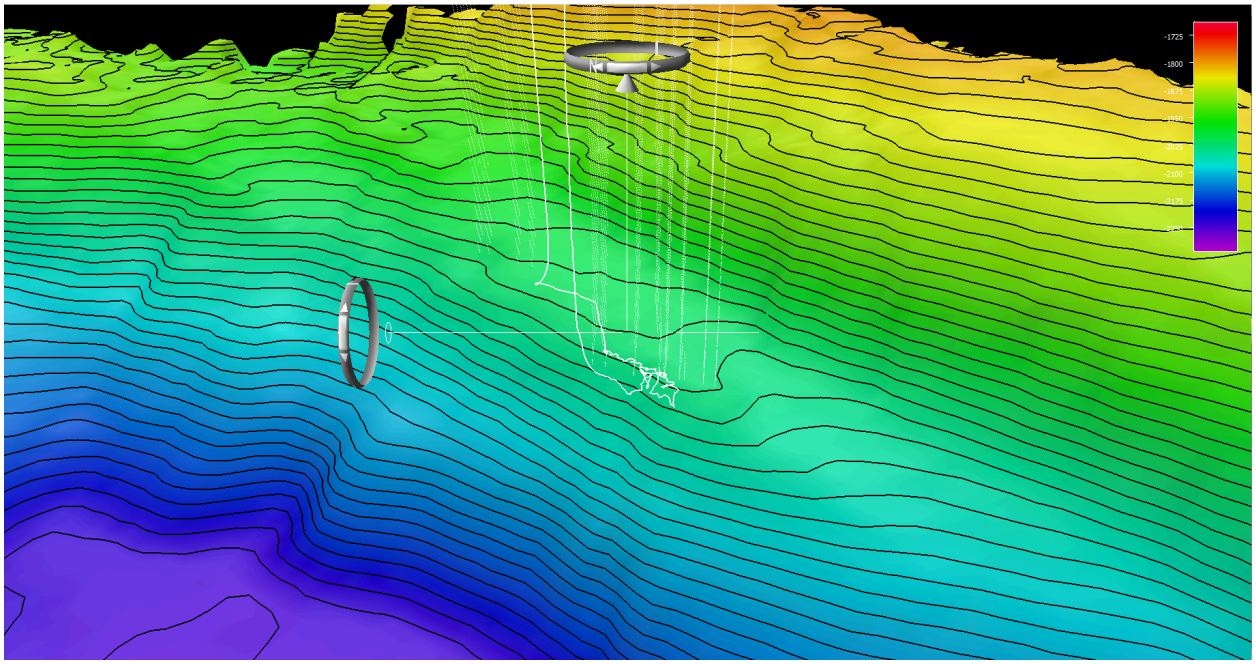


Figure 5. Overview of Sanak Seep showing the ROV track as dove. Depths in meters.

ROV CTD Profile

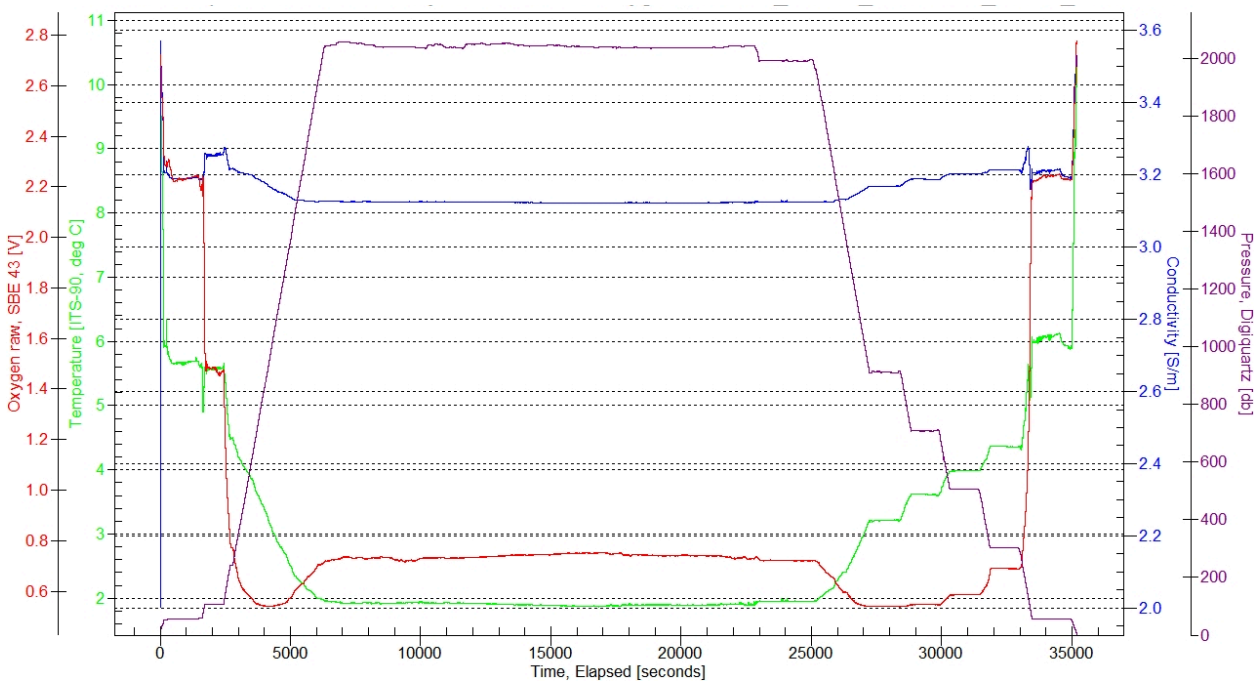


Figure 6. Plot of the ROV CTD profile, showing temperature, conductivity, pressure, and dissolved oxygen over time.

Representative Photos of the Dive

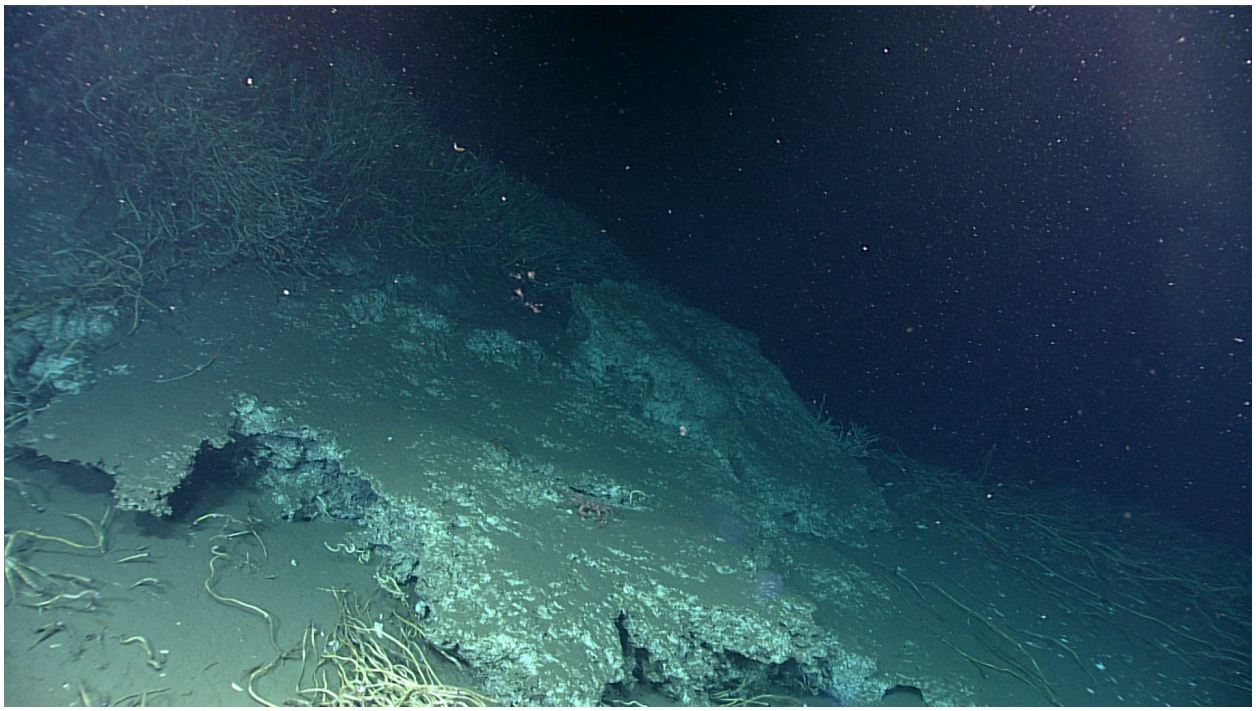


Figure 7. Characteristic rock exposures at the seafloor near 2030 m showing methane-derived authigenic carbonates that locally have cobbles and pebbles cemented in them.

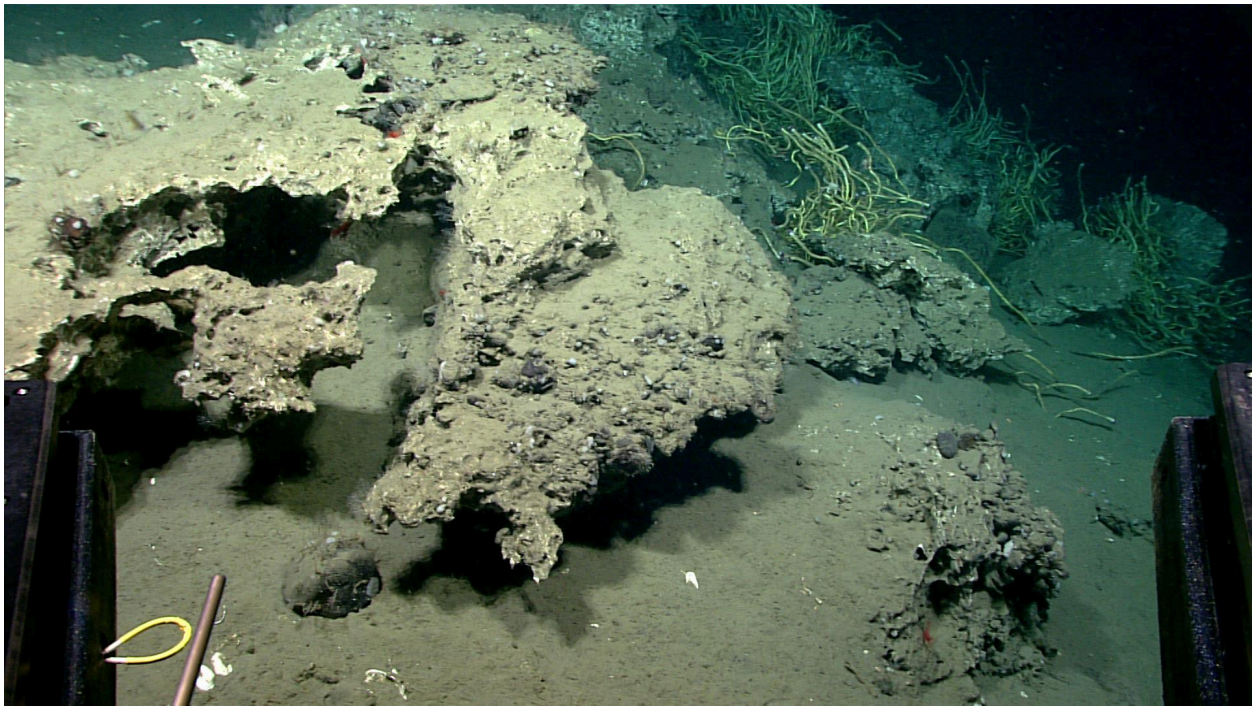


Figure 8. Close-up view of some methane-derived authigenic carbonate outcrops. In this image the pebbles and cobbles appear to be resting on the surface of the carbonate (grey-white rock) but when this sample was collected and inspected we discovered that this is actually a carbonate-cemented conglomerate where the carbonate cement is probably methane-derived authigenic carbonate. The rounded pebbles and cobbles are likely glacial-derived from the last glacial maximum (~26 Ky), and these clasts are cemented with white methane-derived carbonate. This sequence suggests that the methane-derived carbonate is younger than the deposition of the cobbles.

Figure 9. Example of the more massive form of in-situ methane hydrate, with anemones surrounding the edges of the seep.

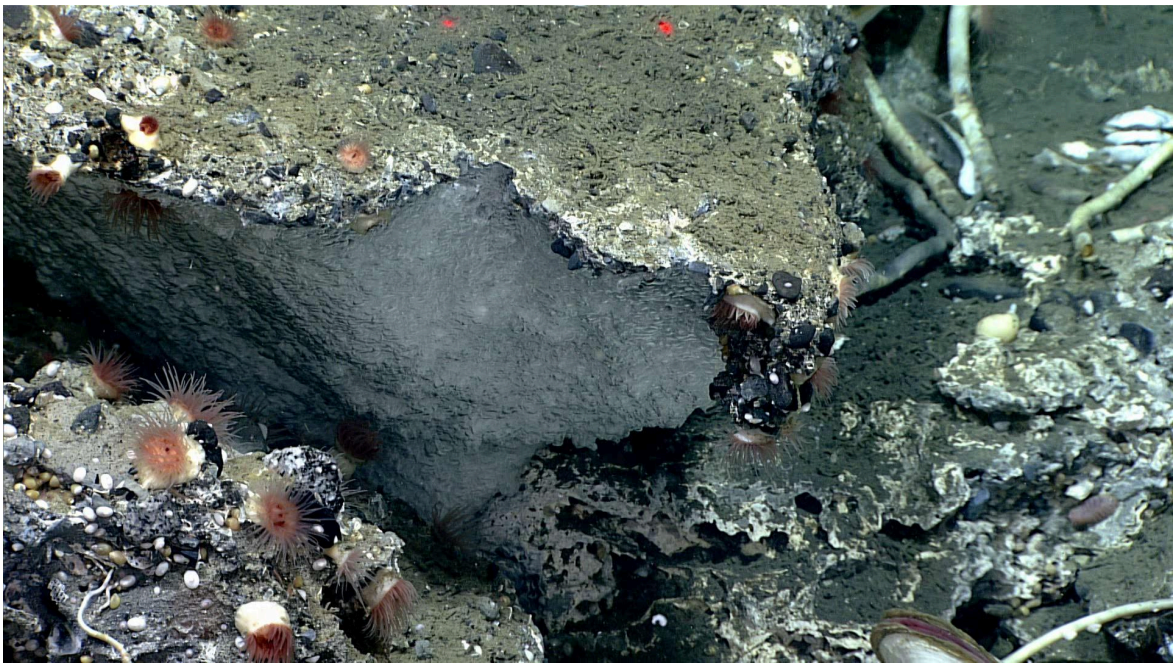


Figure 10. Example of another form of in-situ methane hydrate with a methane-derived carbonate crust capping it.

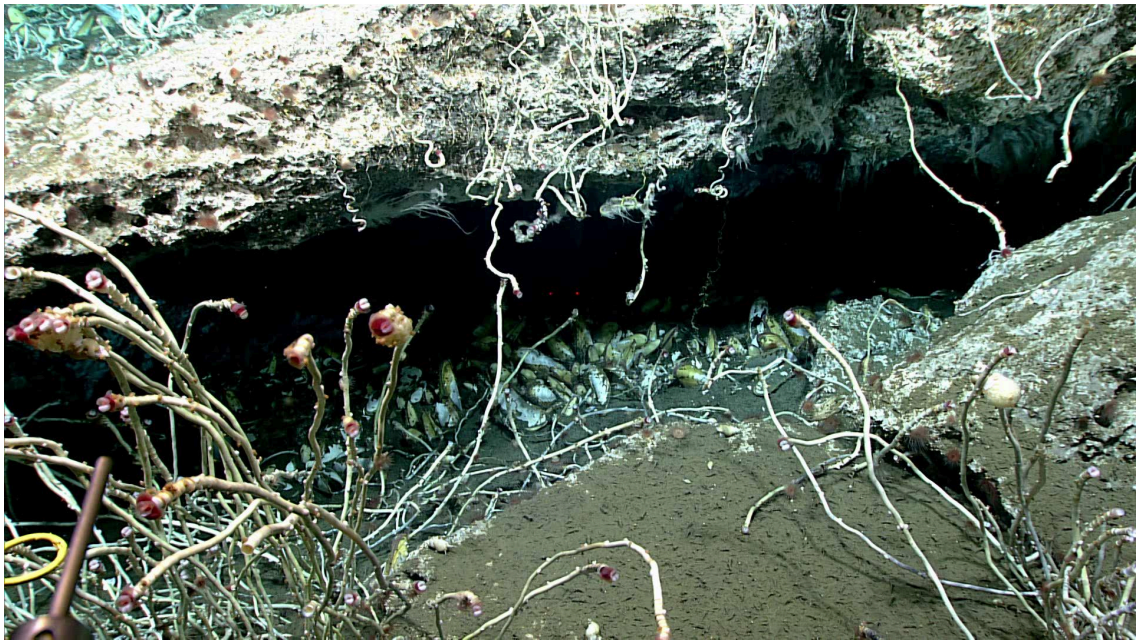


Figure 11. Example of another characteristic methane-derived carbonate, surrounded by what potentially is at least two species of tube worms (Lamellibranchia) with a nest of clams tucked inside the orifice.

Figure 12. This orange mat was observed in several locations around the Lamellibranchia tube worm fields. On collection it was discovered that it was a bacterial mat. it appeared to be overcovering a base of agglutinated tube worms, potentially mineralized by the seep.

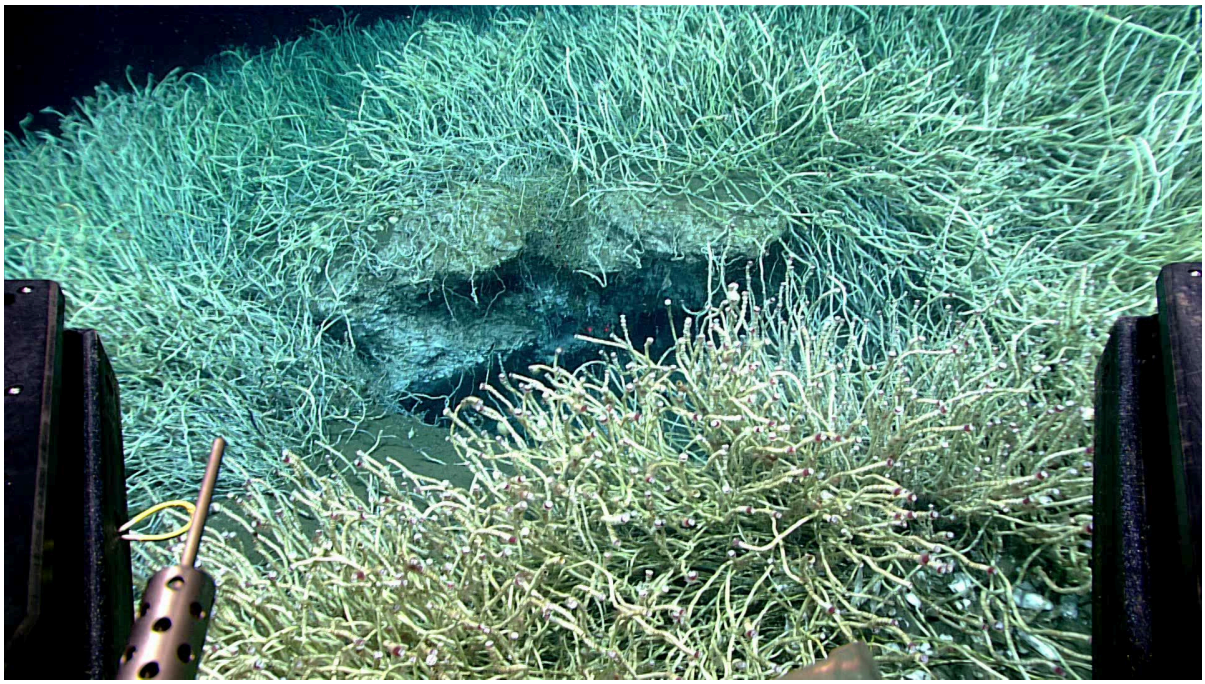


Figure 13. The full extent of the tube worm field was not fully imaged during the dive, but spreads at least 200 m long.

Figure 14. Amongst the tube worm clearings *Vesicomyid* clams were imaged, along with empty shells of *Acharax* mussels (foreground) suggesting they are present deeper in the sediments/between the clams.

Samples Collected

Sample ID	EX2304_D04_02B
Date (UTC)	20230718
Time (UTC)	194022
Depth (m)	2013.09997558594
Latitude (decimal degrees)	53.747917175293
Longitude (decimal degrees)	-162.589797973633
Temp. (°C)	1.94700002670288
Field ID(s)	Sponge Bacteria Unknown
Comments	mix of bacterial sludge, sediment, worm tubes

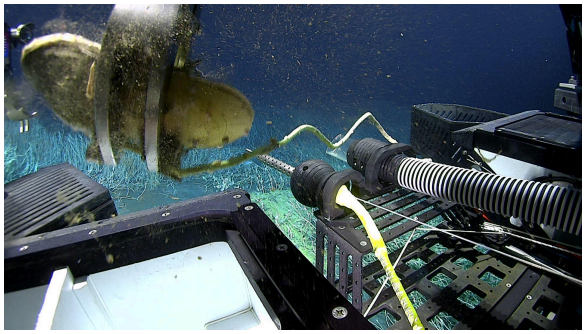
Associates Sample ID:	EX2304_D04_02B_A01B
Field Identification:	Pycnogonida
Count:	3

Associates Sample ID:	EX2304_D04_02B_A02B
Field Identification:	Gastropoda

Count:	12

Associates Sample ID:	EX2304_D04_02B_A03B
Field Identification:	Polychaeta
Count:	20

Associates Sample ID:	EX2304_D04_02B_A04B
Field Identification:	Amphipoda
Count:	2



Sample ID	EX2304_D04_03B
Date (UTC)	20230718
Time (UTC)	194550
Depth (m)	2011.07702636719
Latitude (decimal degrees)	53.7483863830566
Longitude (decimal degrees)	-162.588317871094
Temp. (°C)	1.92799997329712
Field ID(s)	Vesicomyidae
Comments	N/A

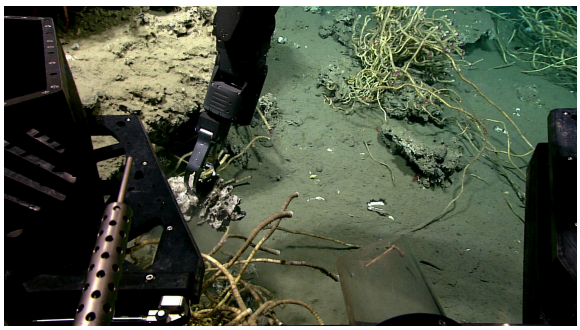
Associates Sample ID:	EX2304_D04_03B_A01B
Field Identification:	Siboglinidae
Count:	1

Associates Sample ID:	EX2304_D04_03B_A02B
Field Identification:	Patellogastropoda
Count:	1

Associates Sample ID:	EX2304_D04_03B_A03B

Field Identification:	Patellogastropoda
Count:	6

Associates Sample ID:	EX2304_D04_03B_A04B
Field Identification:	Gastropoda
Count:	4



Sample ID	EX2304_D04_04G
Date (UTC)	20230718
Time (UTC)	204322
Depth (m)	2024.27099609375
Latitude (decimal degrees)	53.7488136291504
Longitude (decimal degrees)	-162.589782714844
Temp. (°C)	1.89999997615814
Field ID(s)	Carbonate Rock
Comments	carbonate cemented conglomerate; conglomerate class size ranges from 2-8cm class are subangular to subrounded, ungraded disorganized fabric; methane derived calcium carbonate cement?; max diameter 29 cm; some clasts have slimy film.

Associates Sample ID:	N/A
Field Identification:	N/A
Count:	N/A

Sample ID	EX2304_D04_06B
Date (UTC)	20230718
Time (UTC)	231212
Depth (m)	2015.76501464844
Latitude (decimal degrees)	53.747875213623
Longitude (decimal degrees)	-162.587112426758
Temp. (°C)	1.90799999237061
Field ID(s)	Siboglinidae
Comments	has large egg mass around the tube; covered in limpets.

Associates Sample ID:	EX2304_D04_06B_A01B
Field Identification:	Tritonia
Count:	1

Associates Sample ID:	EX2304_D04_06B_A02B
Field Identification:	Patellogastropoda
Count:	13

Niskin Sampling Summary

Sample ID	EX2304_D04_01W
Date (UTC)	20230718
Time (UTC)	174650
Depth (m)	241.619995117188
Latitude (decimal degrees)	53.7508316040039
Longitude (decimal degrees)	-162.588912963867
Bottle Number	Niskin Bottle 1
Temperature	4.48999977111816
Dissolved Oxygen (mg/L)	1.582000017
Treatment	DNA/RNA Shield

Sample ID	EX2304_D04_05W
Date (UTC)	20230718
Time (UTC)	22:02:31
Depth (m)	2009.69396972656
Latitude (decimal degrees)	53.748176574707
Longitude (decimal degrees)	-162.588638305664
Bottle Number	Niskin Bottle 2
Temperature	1.89400005340576
Dissolved Oxygen (mg/L)	2.002000093
Treatment	DNA/RNA Shield

Sample ID	EX2304_D04_07W
Date (UTC)	20230718
Time (UTC)	232748
Depth (m)	1965.51696777344
Latitude (decimal degrees)	53.747917175293
Longitude (decimal degrees)	-162.586853027344
Bottle Number	Niskin Bottle 3
Temperature	1.95099997520447
Dissolved Oxygen (mg/L)	1.825999975
Treatment	DNA/RNA Shield

Sample ID	EX2304_D04_08W
Date (UTC)	20230719
Time (UTC)	003915
Depth (m)	903.142028808594
Latitude (decimal degrees)	53.7475967407227
Longitude (decimal degrees)	-162.584259033203
Bottle Number	Niskin Bottle 4
Temperature	3.20799994468689
Dissolved Oxygen (mg/L)	0.476000011
Treatment	DNA/RNA Shield

Sample ID	EX2304_D04_09W
Date (UTC)	20230719
Time (UTC)	010634
Depth (m)	700.690002441406
Latitude (decimal degrees)	53.7476577758789
Longitude (decimal degrees)	-162.583999633789
Bottle Number	Niskin Bottle 5
Temperature	3.62400007247925
Dissolved Oxygen (mg/L)	0.455000013
Treatment	DNA/RNA Shield

Scientists Involved

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Lara	Beckmann	University of Gothenburg
Merlin	Best	Fisheries & Oceans Canada
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Jamie	Conrad	U.S. Geological Survey
Emily	Crum	NOAA Ocean Exploration
John	Deitz	
Meredith	Everett	NOAA
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Sam	Greenaway	NOAA
Elaina	Jorgensen	NOAA
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