Supplementary Material 3 for:

Successional stages of methane seep systems off central Chile: linking active sediment-hosted seepage with long-lived carbonate chemoherms

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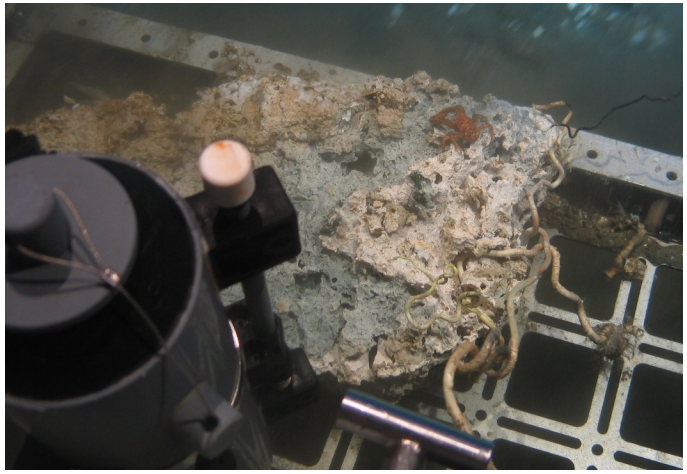
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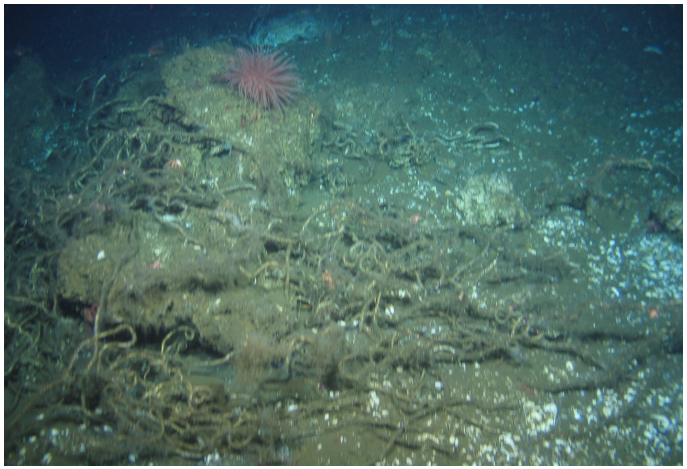
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[†]Deceased

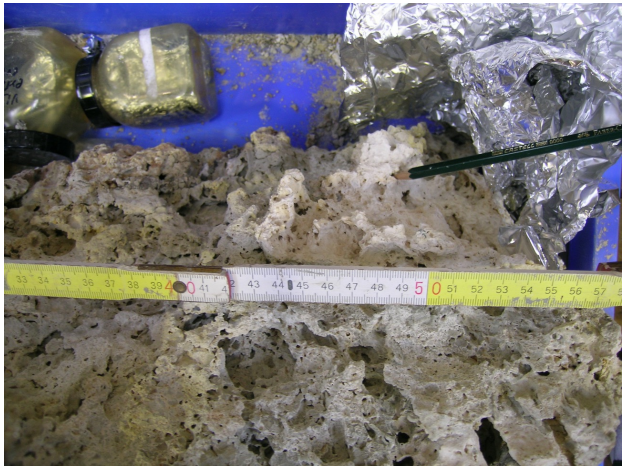
St. 25/ROV 2/Box 4/P-4

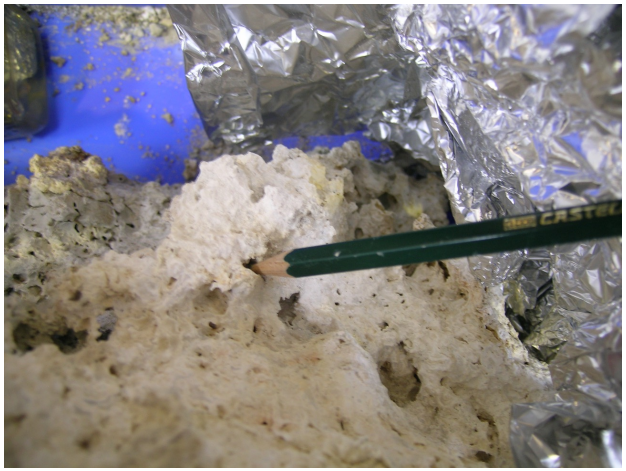
P-4
overview





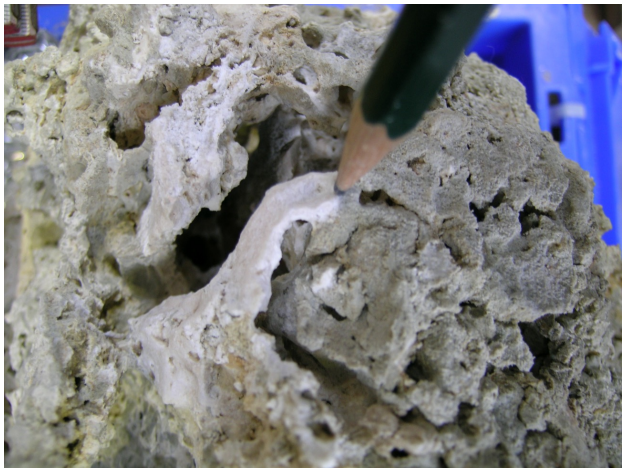
P-4/16/149-11
downside, surface layer





P-4/17/150-11
downside, internal layer





At 683.7 m, the ROV recovered a carbonate sample with attached lamellibrachid tubeworms from a locality characterized by outcropping porous carbonate plates that are intermingled and densely populated by tubeworms.

St. 64/TVG 4/Box 3/TVG-4



Left: Carbonate, collected by TVG from the deepest sampling site (1022 m), consists of a massive block with highly resistant laminated aragonite layers that protect the outer surface from prograding erosion.

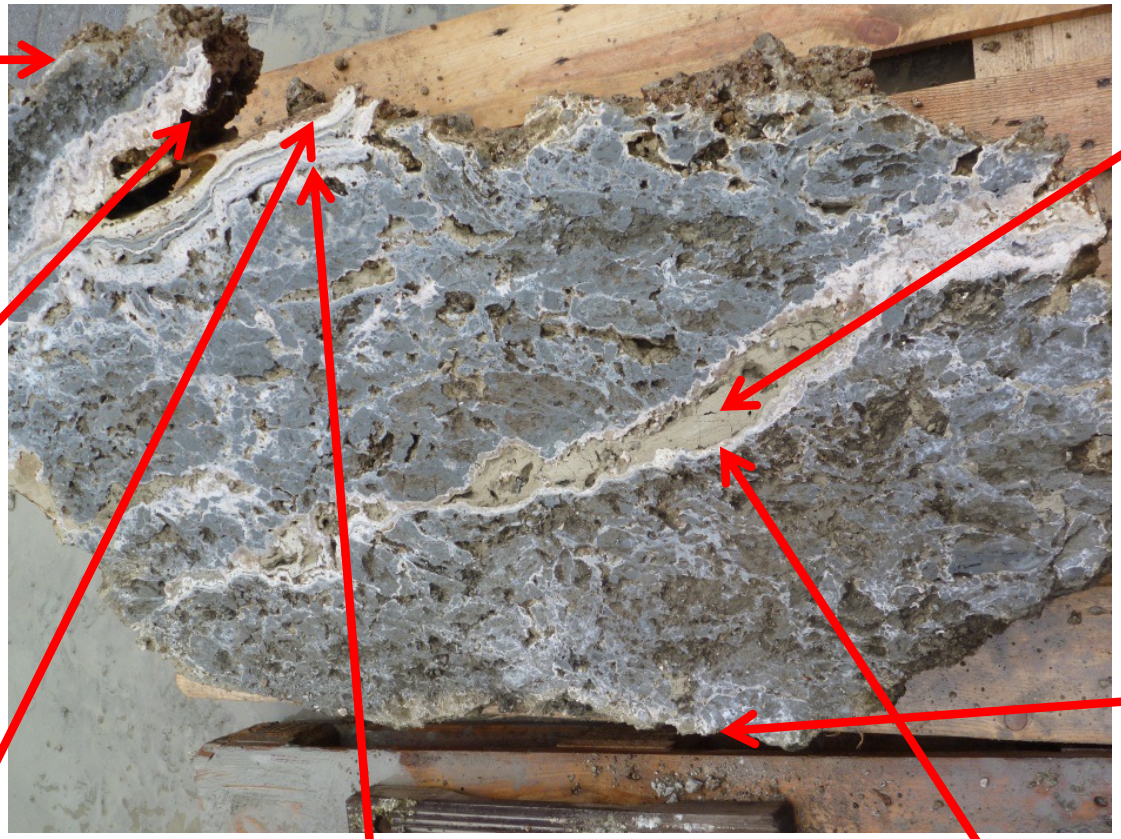


Top: Internal 3D structure recovered by ex-situ chain-saw cutting.



Right: Pockets of soft sediment are preserved within the pore spaces of the block, encased by surrounding layers of laminated aragonite.

TVG-4
subsamples



TVG-4 / 1 / 305-11:
uppermost rim

TVG-4 / 2 / 306-11:
white area of
hanging layer

TVG-4 / 3 / 307-11:
upper white line of
laminated pack

TVG-4 / 4 / 308-11:
lower white line of
laminated pack beneath 3

TVG-4 / 5 / 309-11:
white line beneath "clay“

TVG-4 / 6 / 310-11:
bottom network

TVG-4 / 7 / 311-11:
soft filling (diatom
clay) above 5

St. 69/TVG 5/Box 1/TVG-5

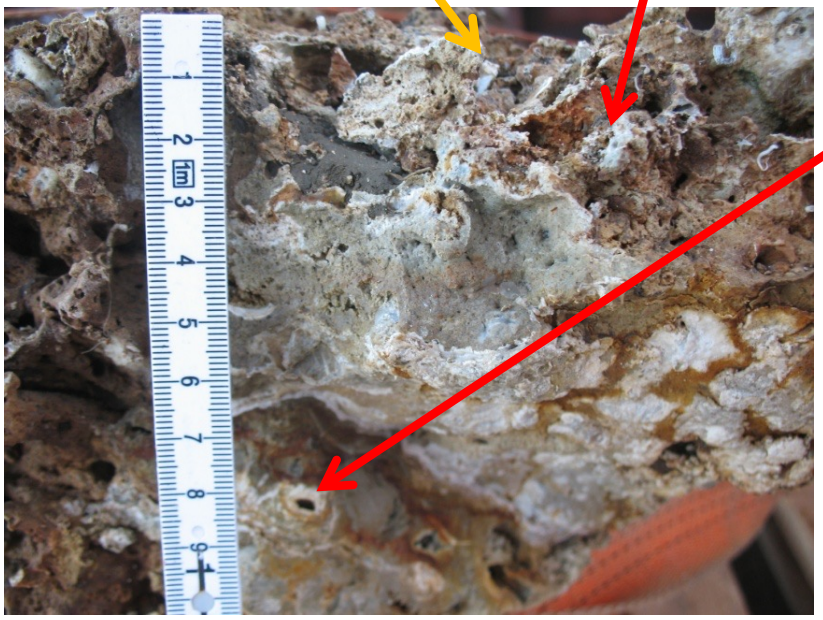
Right: A rounded, flat block of consolidated sediment was collected from 670 m, characterized by a dispersed network of veins and tube-like pore spaces partially filled with aragonitic material.





P-5 / 18 / 151-11:
disperse network

Right: Zoomed-in area where P-5 samples were collected



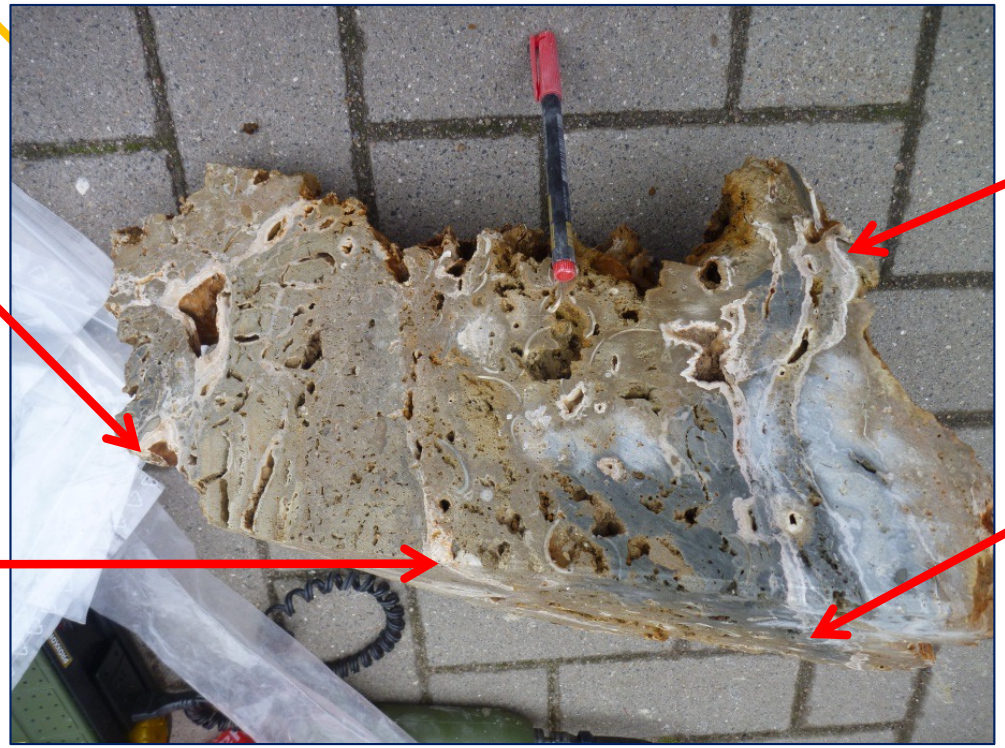
P-5 / 19 / 152-11:
pore volume filling



St. 69/TVG 5/Box 1/TVG-5



Left: The internal 3D structure of the carbonate collected at 670 m by TVG was exposed by ex situ chain-saw cutting, revealing multiple semi-horizontal aragonite layers interspersed with open pore spaces that separate distinct matrix domains.



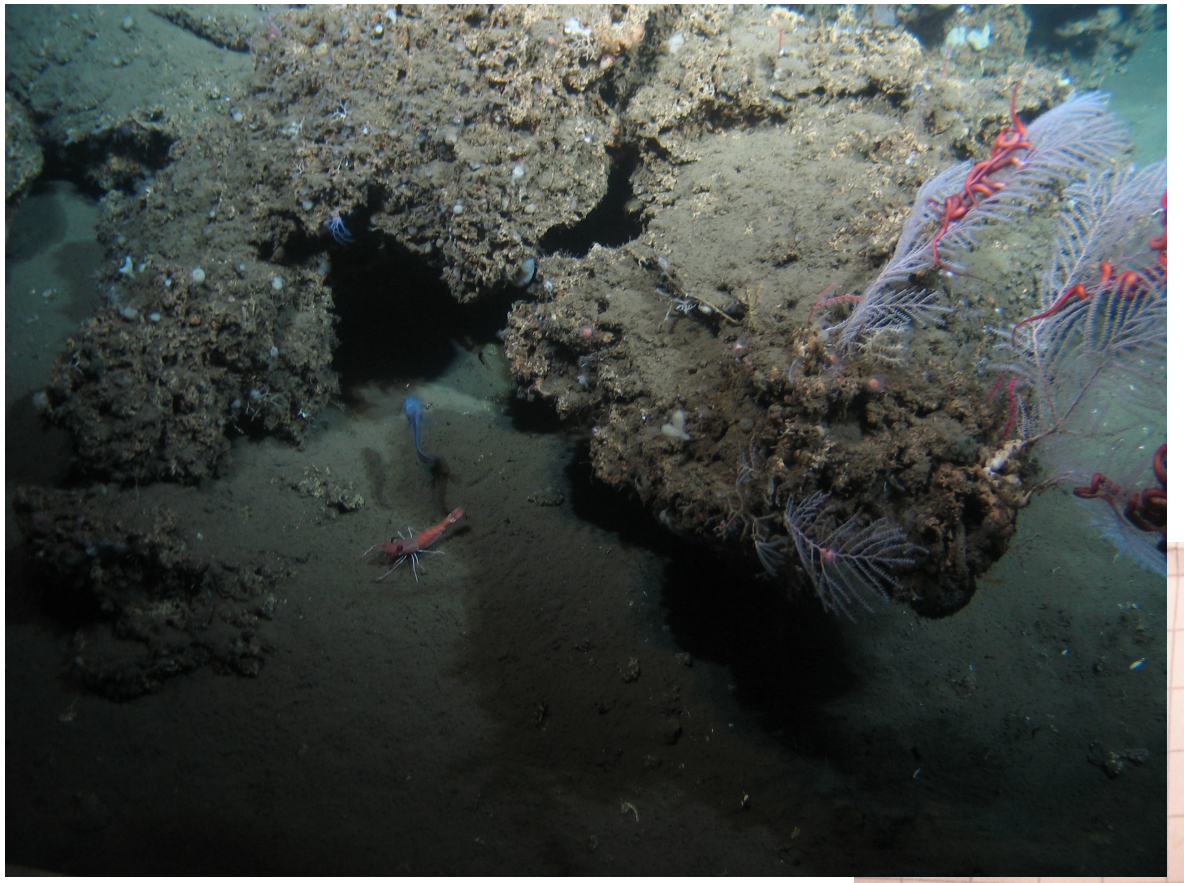
TVG-5 / 1 / 301-11:
upper rim

TVG-5 / 2 / 302-11:
central layer

TVG-5 / 3 / 303-11:
lower vein

TVG-5 / 4 / 304-11:
center area

St. 74/ROV 6/Box 8/P2+ spec



Left: Carbonate structure with soft corals (701.6 m).



Right: Carbonate sample (P2+ spec) collected by ROV from the lowest level of the structure.

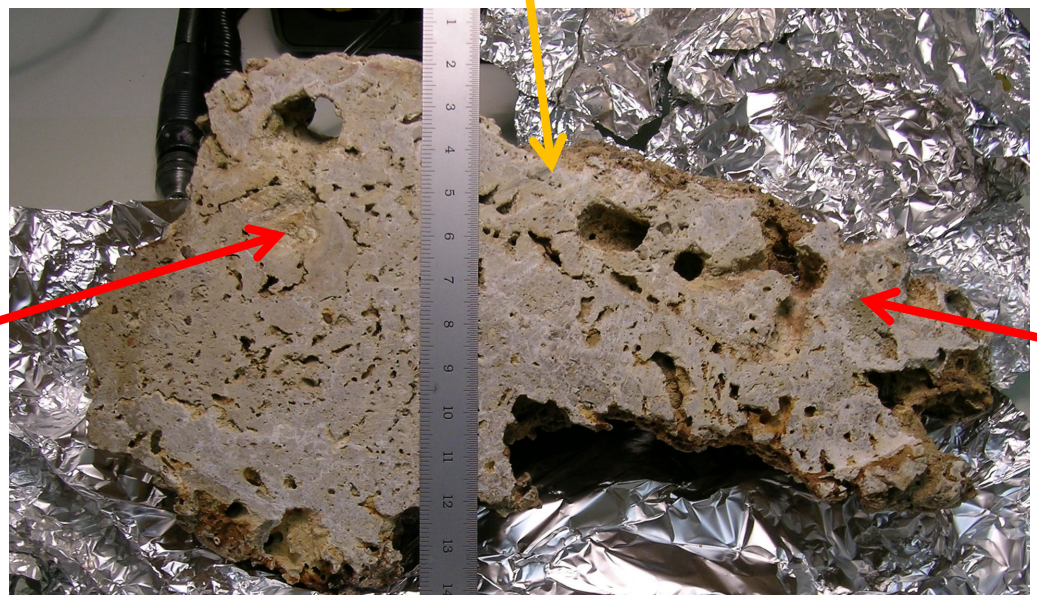
St. 78/ROV 7/Box 1/P9



Left : A section was cut from a massive, flat solitary block at 676.7 m, with living clams and lamellibrachid tubeworms present at its base. The block and associated fauna represent typical habitat and seafloor structures characteristic of Box 1.

P9 / 28 / 155-11:
pore volume filling

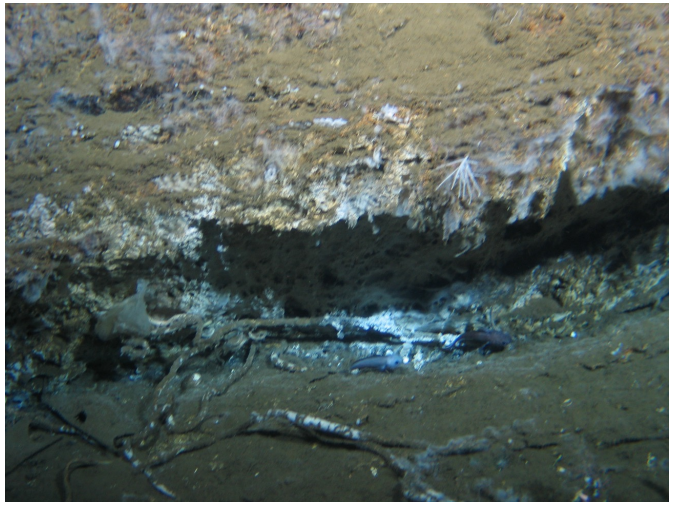




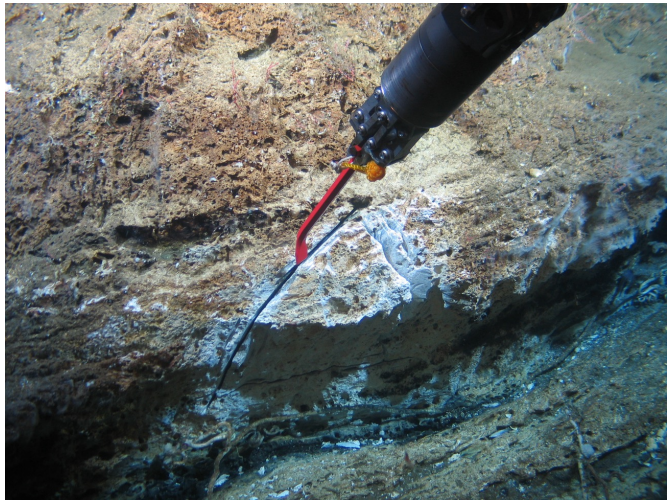
P9 / 5 / 156-11:
disperse vein system



St. 78/ROV 3+ 7/Box 1/P1



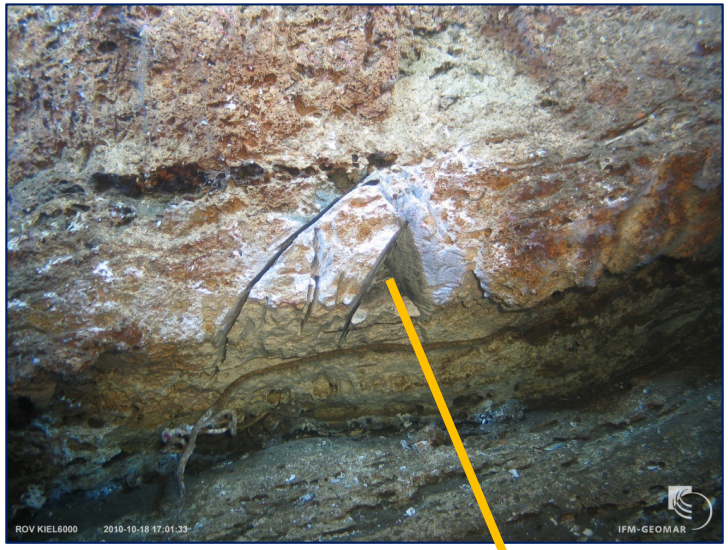


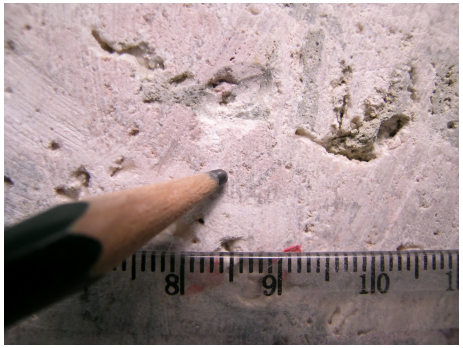




A massive carbonate bank, reaching heights of up to ~1 m, was documented at 667.0 m water depth. The structure exhibits erosional rounding, and living lamellibrachid tubeworms and bacterial mats were observed at its base. During ROV-3 operations, approximately three hours of chain-saw work were required to section the block, employing a three-dimensional “triangular” cutting approach that placed significant demands on the hydraulic system and ultimately required a reduction in sample size. Operations were terminated following hydraulic leakage in the fixation arm. Final sample recovery was achieved during ROV-7 using a chisel-based approach.

St. 78/ROV 3+ 7/Box 1/P1





P1 / 4 / 145-11:
rose



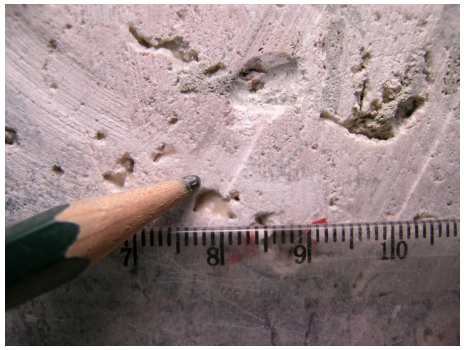
P1 / 3 / 144-11:
outer white

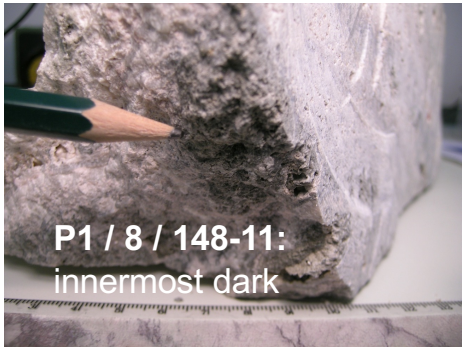


P1 / 7 / 147-11:
innermost white



P1 / 5 / 146-11:
inner white

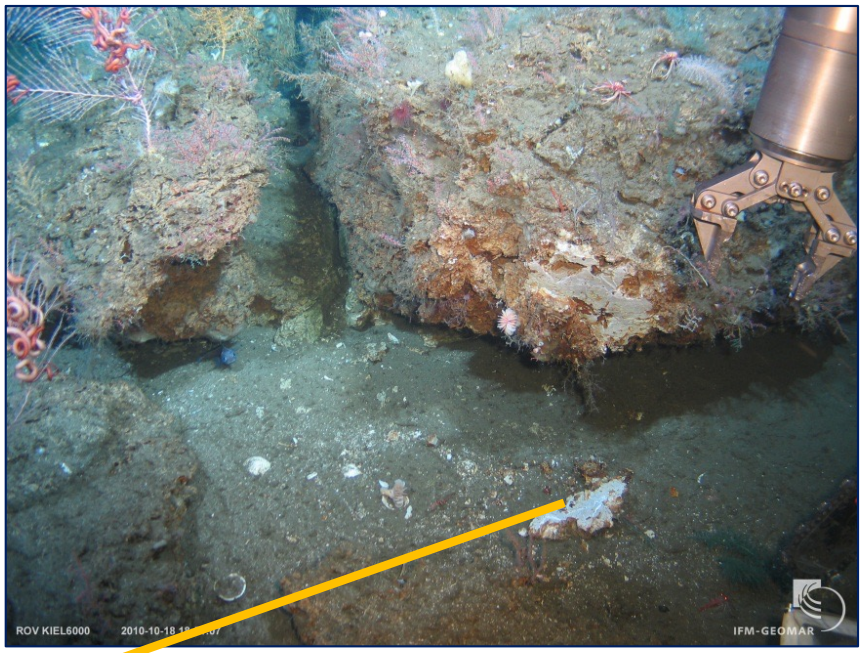




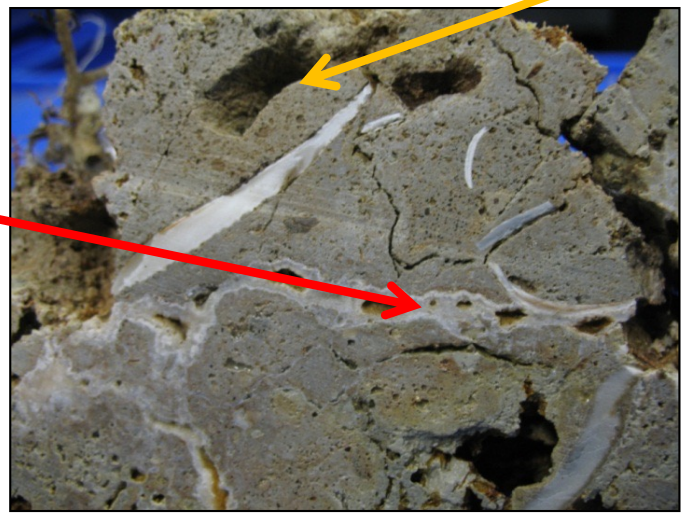
P1 / 8 / 148-11:
innermost dark

St. 78/ROV 7/Box 1/P7





P7 / 22 / 154-11: massive aragonitic vein filling

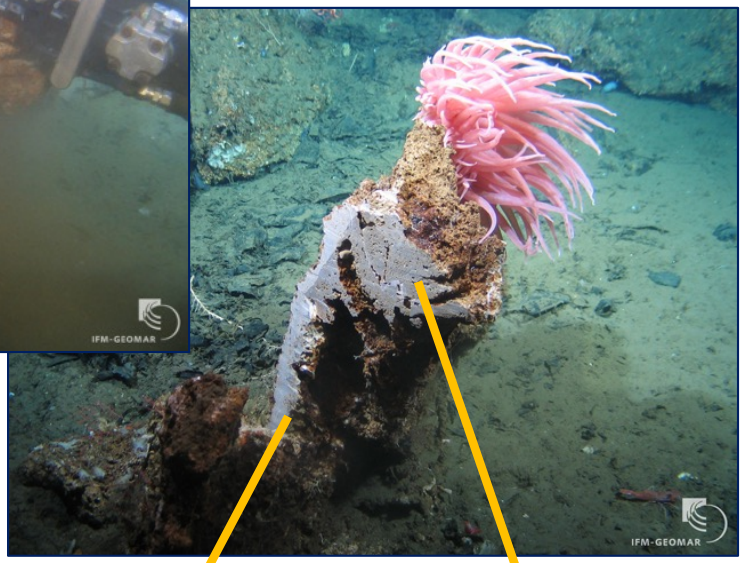


Top and left: Precise sampling of a massive carbonate at the shallowest site (660.6 m) recovered a dense, consolidated matrix characterized by open vein structures and inclusions of clam-shell fragments.

St. 78/ROV 7/Box1/P6



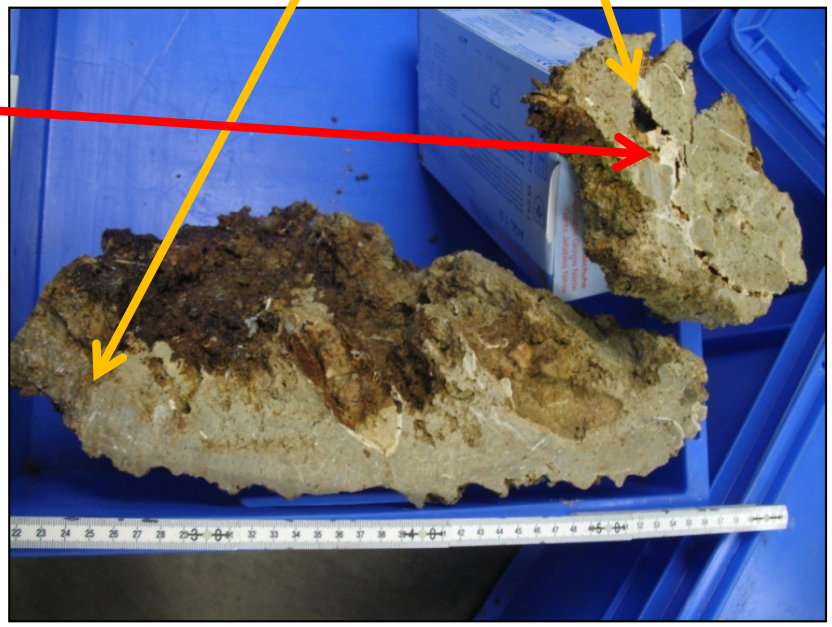




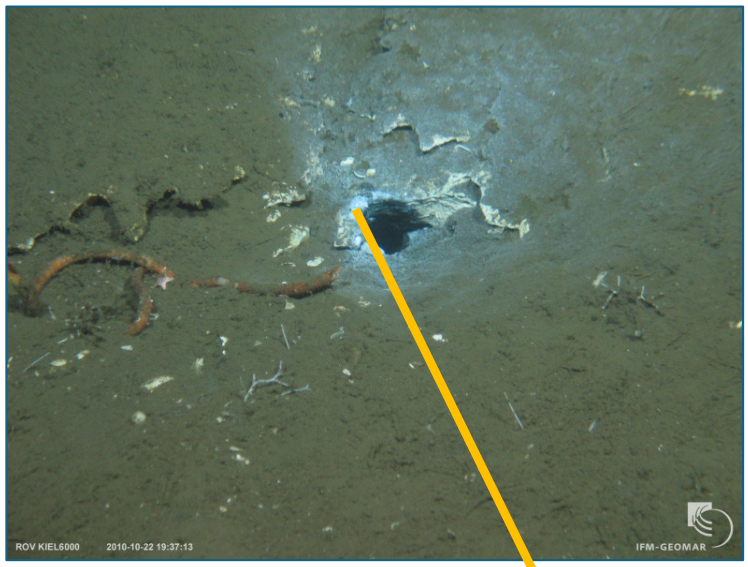
A rare but characteristic vertical structure was encountered at 675.8 m, representing an inactive fluid conduit eroded from previously soft sediment. The recovered block consists of a dense, cemented matrix with open and aragonite-filled veins. It was retrieved in two pieces, with the yellow arrows indicating the respective cut locations.

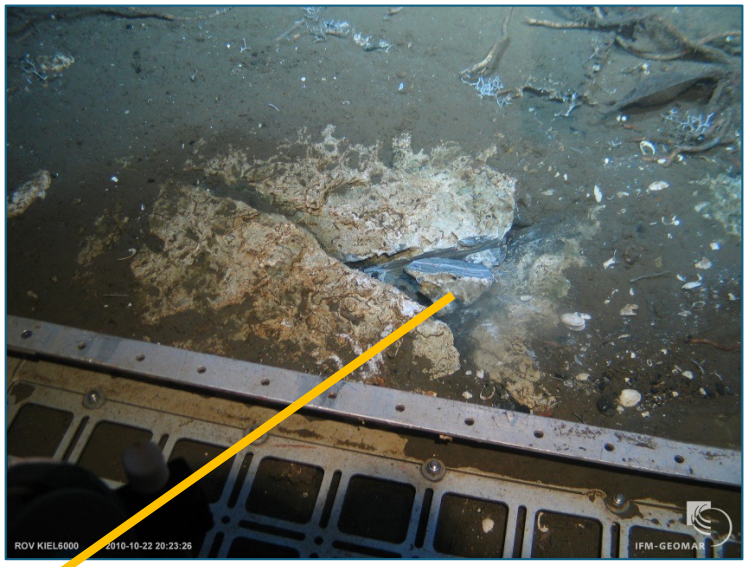
P6 / 20 / 153-11:
massive aragonitic vein filling

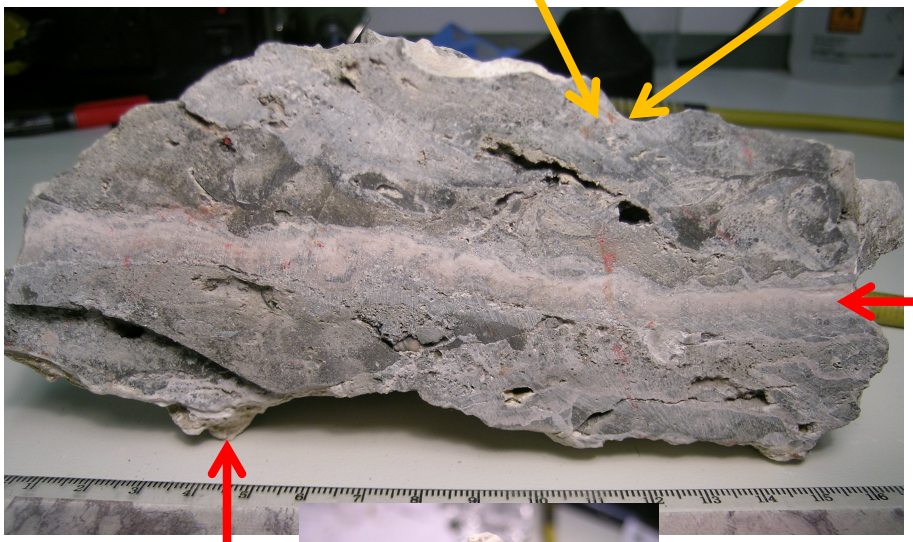


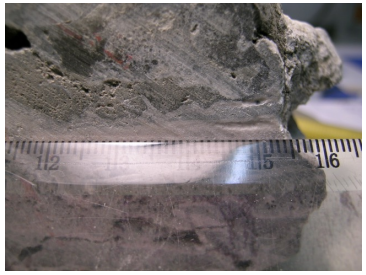


St. 95/ROV 10/Box 1/P+1









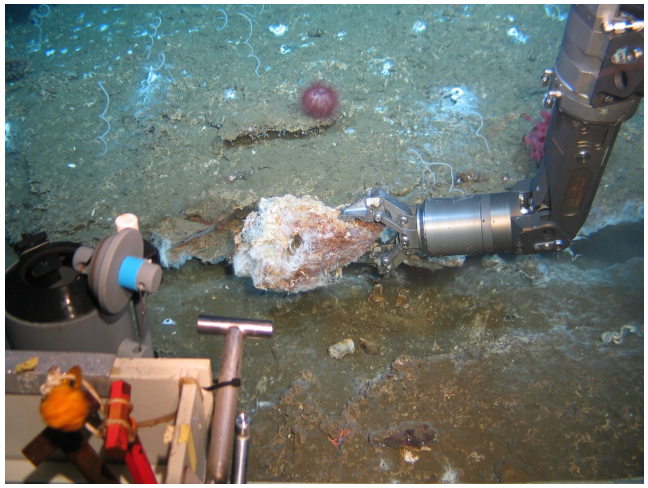
P+1 / 2 / 140-11:
solid center layer

P+1 / 3 / 141-11:
loosely packed granulate

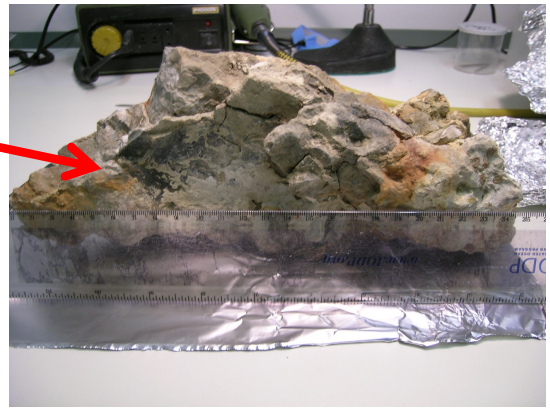


An open vent structure with sulfure bacteria mats and adjacent lamellibrachid tubeworms was identified within a sediment-covered massive carbonate block on a flat area at 685.5 m. Downward cutting with the ROV chain saw enabled sampling of the structure. The surrounding substrate was so strongly cemented that sediment push coring was not possible.

St. 98/ROV 11/Box 3/P0





P0 / 2 / 142-11:
seepage opening,
hard carbonate




P0 / 1 / 142-11:
seepage opening,
soft carbonate

Top photos: A carbonate fragment was detached from a large overhanging carbonate plate at 1008 m. A crack beneath the plate may indicate an active seepage pathway. Both the fragment and the surrounding carbonate surfaces—above and below the crack—were densely coated with filamentous sulfur-oxidizing bacterial mats.