



# Biogeochemical evidence of anaerobic methane oxidation on active submarine mud volcanoes on the continental slope of the Canadian Beaufort Sea

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## Introduction

Active mud volcanoes (MVs) were discovered on the continental slope of the Canadian Beaufort Sea (e.g. Blasco et al., 2013; Saint-Ange et al., 2014). A recent study based on sediment coring, detailed mapping with an autonomous underwater vehicle, and exploration with a remotely operated vehicle suggested that these volcanoes are young and actively forming features experiencing ongoing eruptions (Paull et al., 2015). The escaping gas was largely methane with its isotopic composition of a biogenic origin. The extensive thickets of siboglinid tubeworms and white bacterial mats on the seafloor of these mud volcanoes were indicative of the occurrence of the anaerobic oxidation of methane (AOM) in this chemosynthetic ecosystem. However, biogeochemical processes of archaeal-associated AOM are not investigated in this system yet. Hence, we investigated 3 sediment cores retrieved from the active MVs during the ARA05C expedition in 2014. We aimed to identify microbial AOM processes in this system, applying integrated lipid and nucleic acid analyses.

## Study site

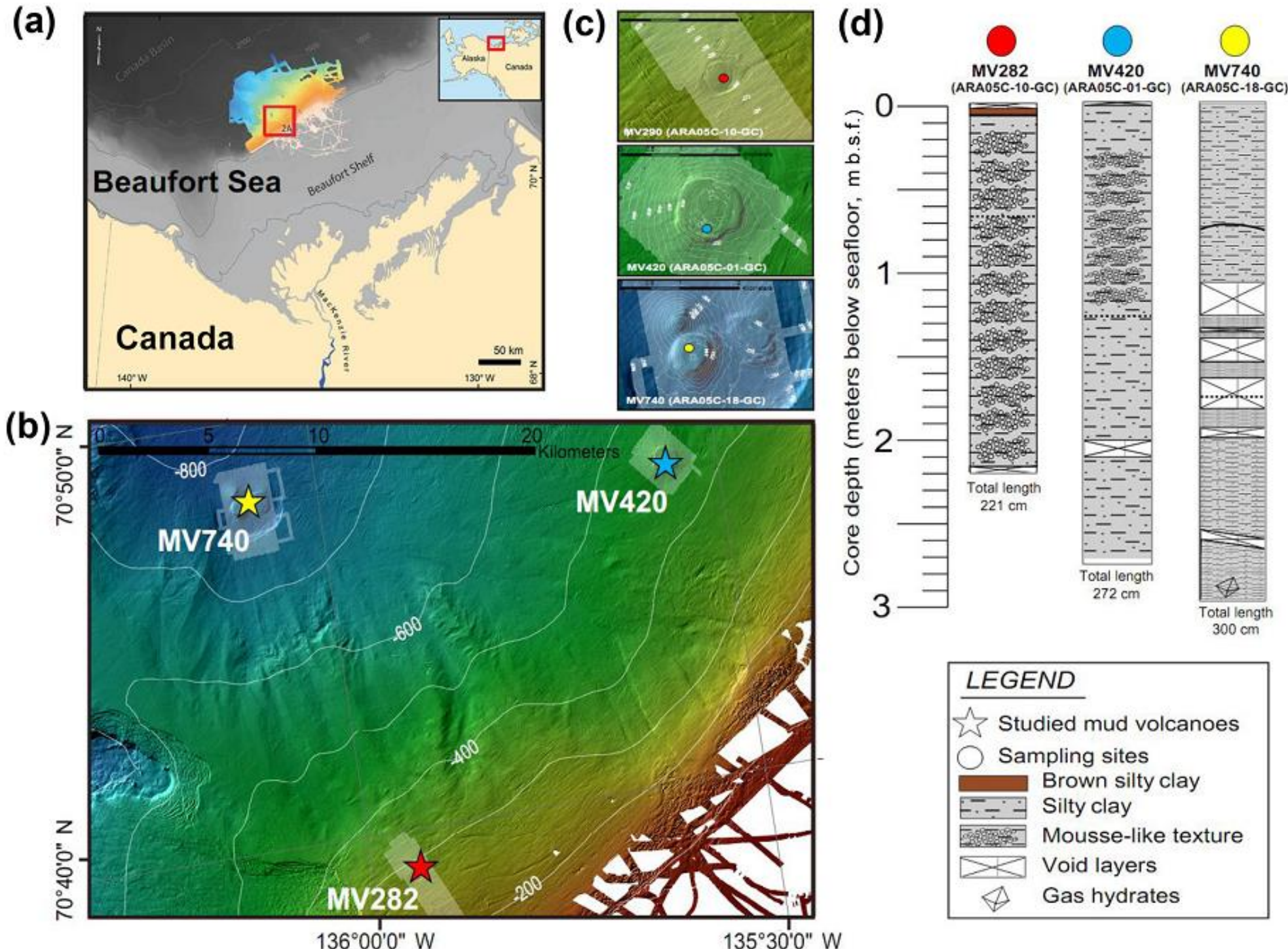


Fig. 1. (A) Map showing the study area (red box) with inset regional map of Alaska and northwestern Canada modified from Paull et al. (2015). (B) Map showing the three mud volcano (MV) locations on the upper slope of the Beaufort Sea. (C) Detailed bathymetric maps showing the locations of sediment cores ARA05C-10-GC (MV282), ARA05C-01-GC (MV420), and ARA05C-18-GC (MV740). (D) Lithology of the three sediment cores investigated.

## Methane-related lipid biomarkers

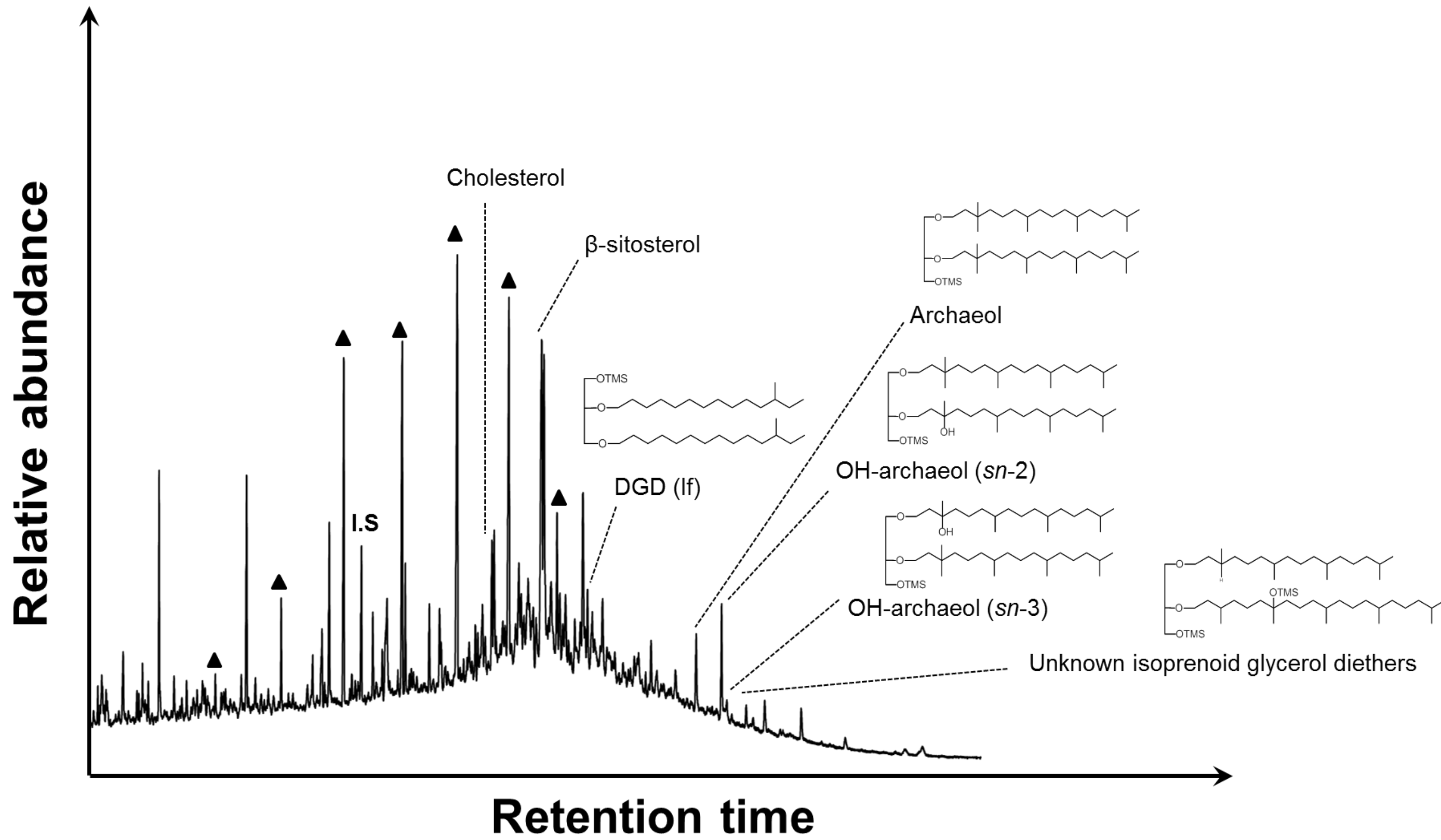


Fig. 2. Examples of GC-MS chromatograms of polar fractions obtained from sediment cores (A) ARA05C-10-GC (MV282): core depth 0.1 m, (B) ARA05C-01-GC (MV420): core depth 0.7 m, and (C) ARA05C-18-GC (MV740): core depth 0.8 m. Solid triangles denote n-alcohols.

## Results

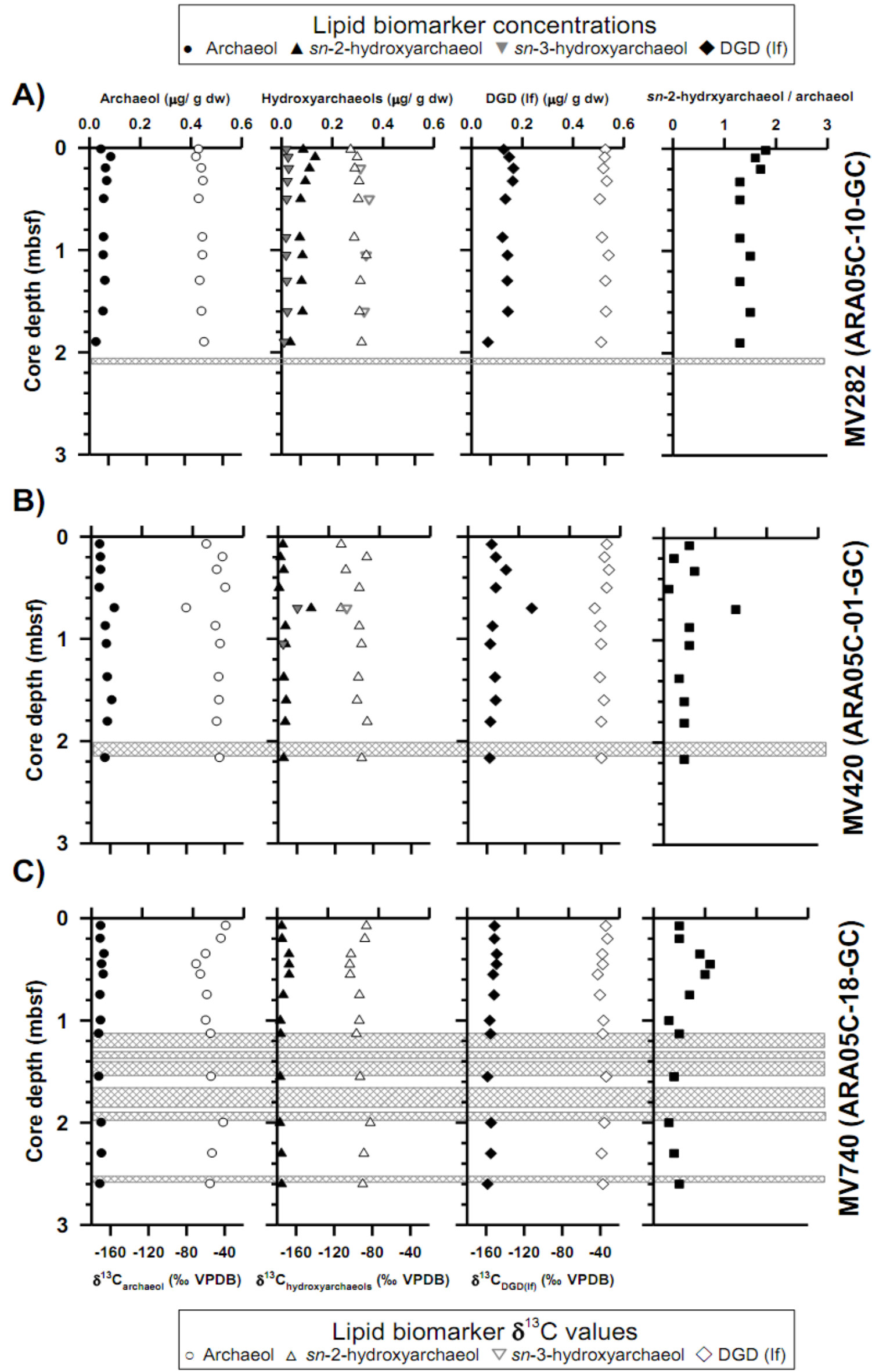


Fig. 3. Vertical profiles of selected lipid biomarkers (archaeol, hydroxyarchaeol, and DGD (If)) obtained from sediment cores (A) ARA05C-10-GC (MV282), (B) ARA05C-01-GC (MV420), and (C) ARA05C-18-GC (MV740). Grey hatched bars indicate gas gaps in sediment layers

## Conclusion

We detected specific AOM-related biomarkers (OH-archaeol) with <sup>13</sup>C-depleted values (−86.2‰ to −113.9‰) and Euryarchaeota *Methanosarcinales* in investigated sediments. This is indicative of the presence of anaerobic methane oxidizing archaea (ANMEs). The ratio of *sn*-2-hydroxyarchaeol relative to archaeol and the archaeal 16S rRNA gene sequence results supported the involvement of ANME-2c and ANME-3 in AOM at Beaufort Sea MVs. Accordingly, it appears that CH<sub>4</sub> is, to a limited extent, being oxidized in the Beaufort Sea MVs investigated. Given that our gravity coring system failed to recover the uppermost surface sediments, preventing us from detecting the most active AOM occurrences in the Beaufort Sea MVs, further studies should investigate the undisturbed uppermost surface sediments to investigate the diversity and distribution of AOM communities and to characterize their habitats in the Beaufort Sea MV systems

## Reference

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- Saint-ange, F., Kuus, P., Blasco, S., Piper, D. J. W., Hughes, J. and Mackillop, K.: Multiple failure styles related to shallow gas and fluid venting, upper slope Canadian Beaufort Sea, northern Canada, Mar. Geol., 355, 136–149, 2014.

## Acknowledge

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