Uncultured ANME-1 archaea gain energy from either methanogenesis or anaerobic oxidation of methane

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Uncultured archaea in the Methanomicrobia (ANME-1) perform the anaerobic oxidation of methane (AOM), or reverse methanogenesis. The majority of marine sediments lack advective transport of methane, so AOM occurs in the sulfate methane transition zone (SMTZ) where sulfate-reducing bacteria make methanogenesis exergonic in the reverse direction by consuming hydrogen. When sulfate is depleted, fermentative hydrogen increases and forward methanogenesis becomes energy-yielding. We found that ANME-1 comprised 99.24% of 16S rRNA genes from Methanomicrobia in the SMTZ and 99.95% in the methanogenesis zone in White Oak River estuarine sediments. Each of the 16 ANME-1 OTUs (97%) had peaks in the SMTZ that coincided with peaks of sulfate reducing bacteria *Desulfatiglans sp.* and SEEP-SRB1. In the methane production zone, ANME-1, but no putative sulfate-reducing bacteria, increased with depth. We re-analyzed public genomic DNA to show that ANME-1 was the only potential methanogen present in hydrogen-dependent methane-producing enrichments. We conclude that ANME-1 reverses between AOM in the SMTZ and methane production the methanogenic zone of non-seep marine sediments. This may give ANME-1 a competitive advantage over cultured methanogenic clades in marine sediments, explaining their dominance in methanogenic sediments worldwide.