# Cryptic methane cycle in the upper sediment layers of the Arabian Sea oxygen minimum zone

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Sediments of marine oxygen minimum zones (OMZs) are hot-spots of global carbon-sulfur cycling/sequestration. The water-mass spanning 100-1000 mbsl of the Arabian Sea is the thickest and most-hypoxic of all perennial OMZs; yet, little is known about the microbes of its sedimentary C-S cycle. In this study, off India's west-coast, we use high-throughput metagenomics to reveal the sediment microflora, focussing on the population dynamics of sulfate-reducers, methanogens, methanotrophs and acetogens, along two ~3-m-long cores taken from the OMZ center (530 and 580 mbsl water-depths). The ecology is then compared with those of the sediments underlying the two flanks of the OMZ (these were revelaed along 255- and 125-cm-long cores taken at 31 and 1275 mbsl, respectively). Reported seasonal hypoxia in the shallow waters notwithstanding, community-variations down the sediment-depths of 31 mbsl are distinct from the sediments of the perennial OMZ: while 530 and 580 mbsl sediments are indistinguishable, 1275 mbsl, plausibly due to more bottom-water $O_2$, has a slightly different pattern of down-depth variations. *Gammaproteobacteria* dominate sediment ecology at 530, 580 and 1275 mbsl; *Alphaproteobacteria* are additionally prevalent at 1275 mbsl; 31 mbsl sediments are dominated by *Euryarchaeota* and *Firmicutes*. From sediment-surfaces to core-bottoms, diversity decreases for 530 and 580 mbsl but remains largely unchanged for 1275 and 31 mbsl. At 31 mbsl, sulfate-reducers decrease over the top 120 cmbsf while methanogens, methanotrophs and acetogens increase; below 120 cmbsf none of the types vary. For 530, 580 and 1275 mbsl, prevalences of methanogens, methanotrophs, sulfate-reducers and acetogens are maximum in the core-tops; down-depth, all four types decline, albeit via multiple phases of fall and rise; notably, methanotrophs are allthrough more abundant than the other three types. This peculiar population dynamics of methanogens contradicts the lack of detectable methane at all the sample-sites, except 250-295 cmbsf of 580 mbsl. Methane, however, was produced by the 0-30 cmbsf sediments of 530 and 580 mbsl upon four serial enrichments in methanogenic medium; metatranscriptomics corroborated this cryptic, core-top methane cycle of the OMZ center.