Tracing methane in the geological record using chemical fossils

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AMOprox
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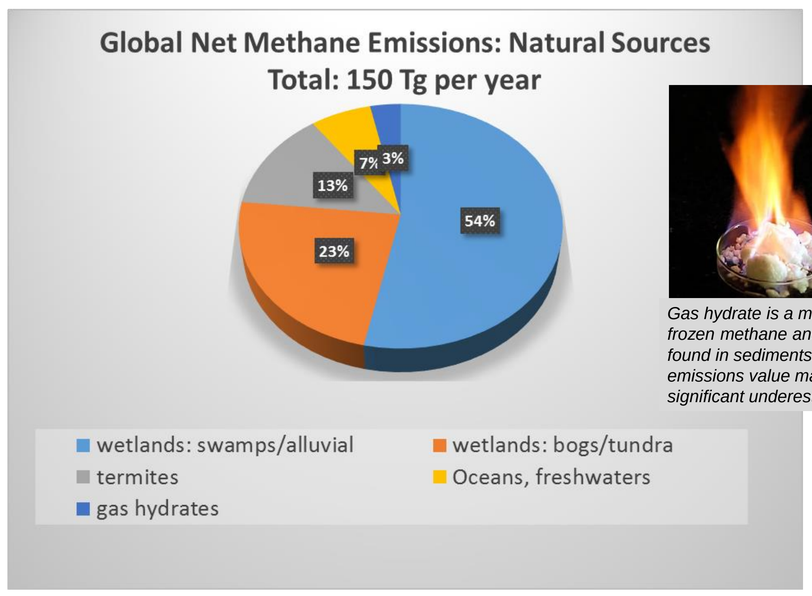
Introduction: Methane

- Methane (CH_4) is an important greenhouse gas
- The level of methane in the atmosphere has been rising for many years
- Natural sources make up ~30% of total emissions to the atmosphere
- Wetlands are the biggest natural source



Gas hydrate is a mixture of frozen methane and water found in sediments. The 3% emissions value may be a significant underestimation

Figure 1. *Global Net CH4 emissions from natural sources (data from Reeburgh , 2007)*

Background: Chemical fossils indicate methane consumption

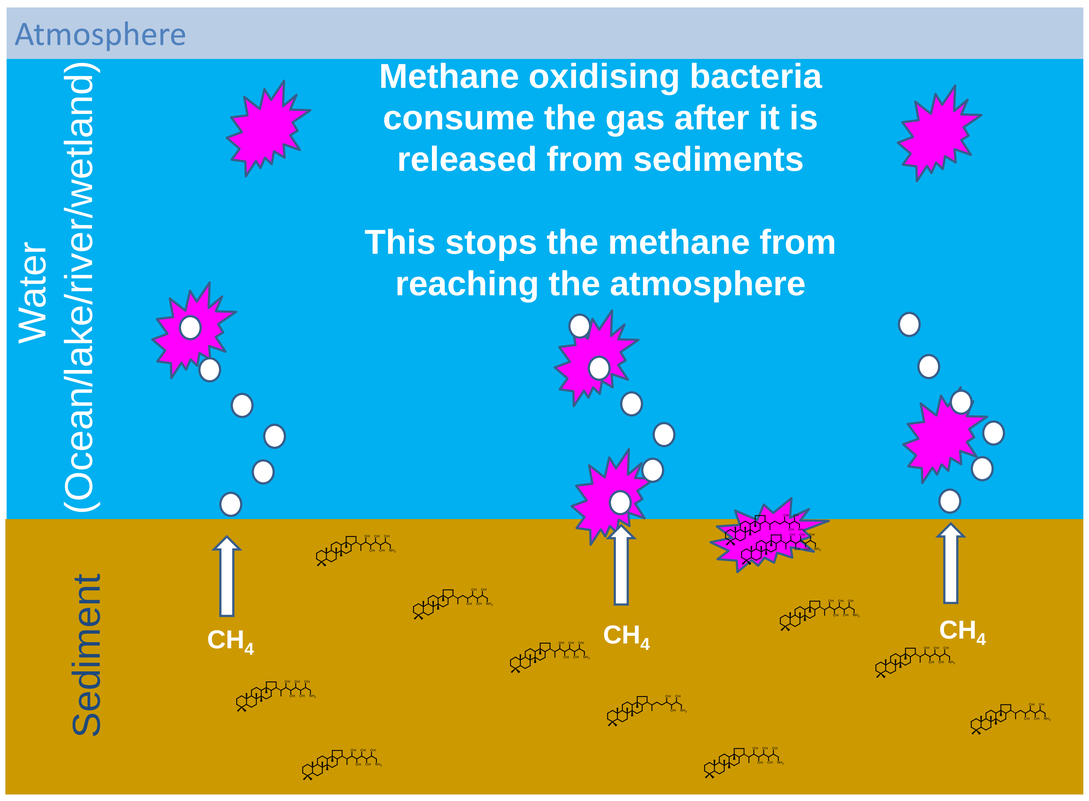
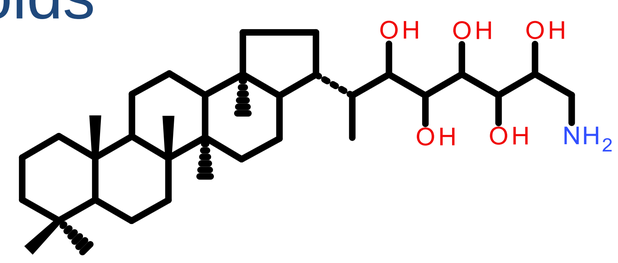


Figure 2. *Schematic diagram of methane production in sediments, consumption by bacteria and deposition of hopanoid chemical fossils in sediments.*

- Bacteria that consume methane are called methanotrophs
- These bacteria make molecules called hopanoids

Aminopentol indicates methane oxidation.
It has been found in sediments over 2.5 million years old



- Hopanoid chemical fossils are found in the sedimentary record wherever these bacteria were active

Case study: The Congo Deep Sea fan

- Aminopentol is found in sediments from the Congo River deep sea fan (site ODP 1075)
- The chemical fossil signal is highest in sediments deposited under warm climate conditions (interglacials)
- At these times lots of methane was being produced and consumed in continental wetlands and then the bacterial remains were transported to ocean sediments via the Congo River (Talbot et al., 2014)

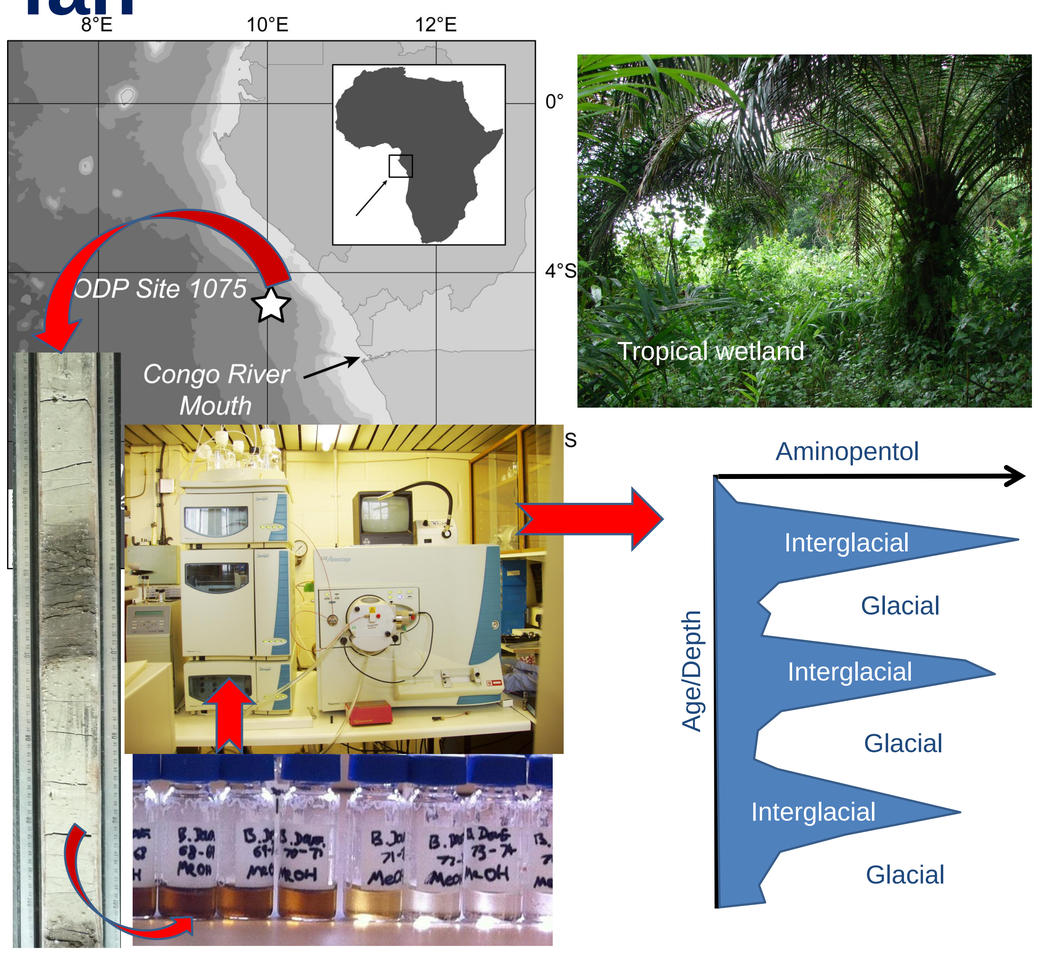


Figure 3. *Generating a record of bacterial methane consumption on land from marine sediment archives.*

Reeburgh, W.S., 2007. Oceanic methane biogeochemistry. Chemical Reviews 107, 486-513. **Talbot, H.M.,** Handley, L., Spencer-Jones, C.L., Dinga, B.J., Schefuß E., Mann, P.J., Poulsen, J.R., Spencer, R.G.M., Wabakanghanzi, J.N., Wagner, T., 2014. Variability in aerobic methane oxidation over the past 1.2 Myrs recorded in microbial biomarker signatures from Congo fan sediments. Geochimica et Cosmochimica Acta 133, 387-401.