Biomarker (brGDGT) degradation and production in lacustrine surface sediments.

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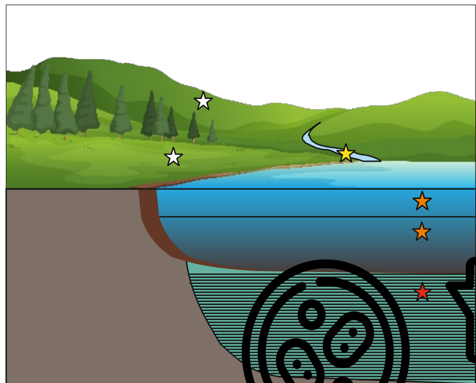
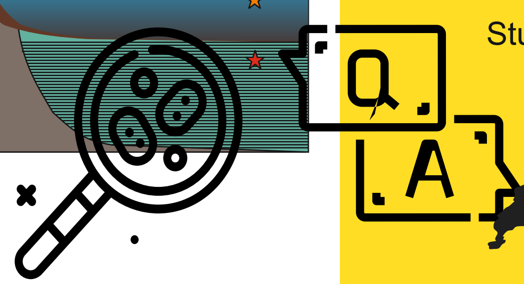
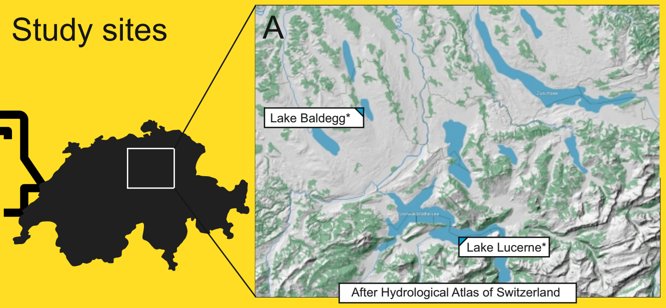




Study sites



<u>We know that:</u>

I. Branched GDGTs (brGDGTs) are membrane lipids produced by heterotrophic bacteria.

II. The distribution of brGDGTs in lake **surface sediments** (summarized in the MBT'$_{5ME}$ ratio) is related to mean annual temperature (Russell et al., 2018).

III. Heterotrophic bacteria are also present and active downcore in lake sediments (i.e. Fiskal et al., 2019).

<u>Question</u>: Is the downcore lacustrine brGDGT signal (and the temperature record) influenced by in-situ bacterial lipid production?

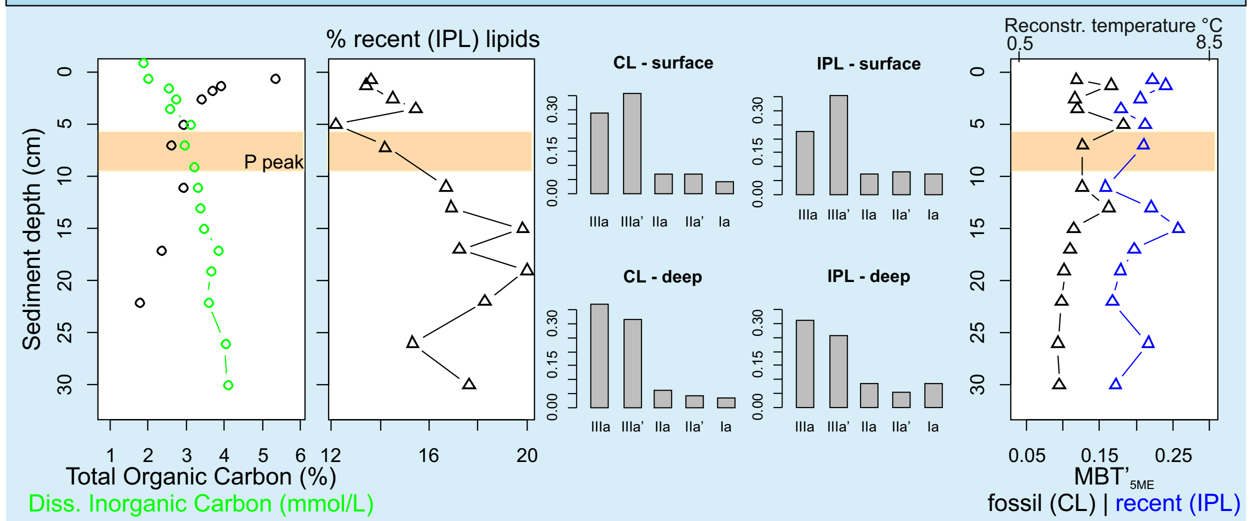
<u>Approach:</u>

Measure fossil (core lipid [CL]) and recently produced (intact polar lipid [IPL]) distributions in top 30-40 cm of lake sediments and compare their distribution.

Core Lipid [CL]	Intact Polar Lipid [IPL]
Degraded compound	Non-degraded compound
"Fossil" - older	Recently produced

Lake Luzern - Oligotrophic - Oxic water column

Core collected at 24m water depth - Sediments anoxic below 0.5 cm blf - Max. sediment age ~ 190 yr.

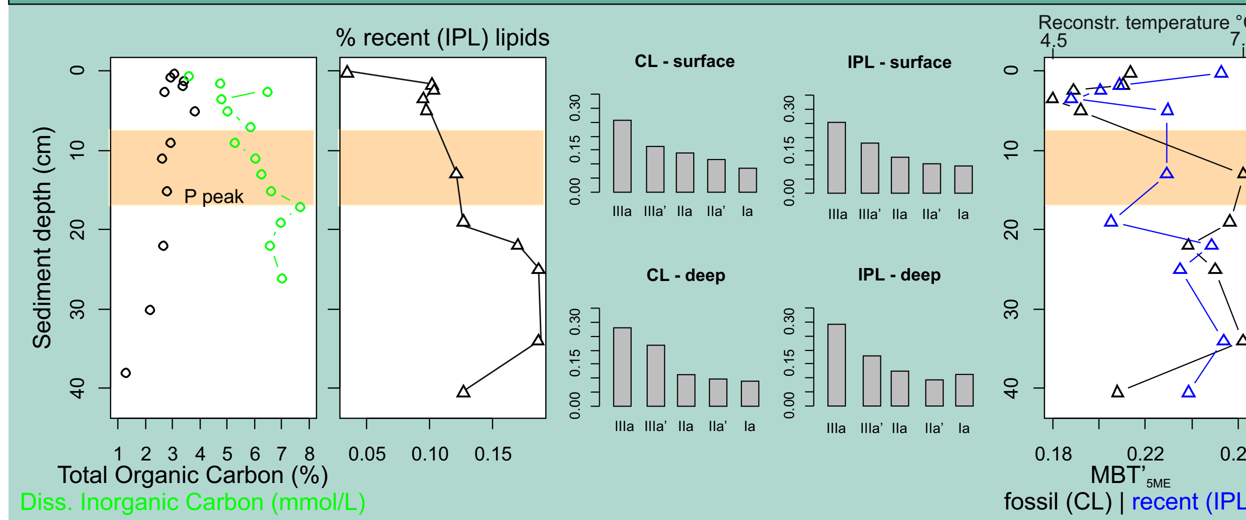


Although most microbial degradation of OM happens in top 5 cm (decrease in TOC), the percentage of brGDGT lipids produced recently (IPL) increases in deeper sediments (>15 cm). This increase in % IPL correlates with an increase in brGDGT IIIa (%) in the core lipid fraction.

The distribution of core lipid (CL) brGDGTs changes downcore, with an increase of brGDGT IIIa. Compared to the CL fraction, the intact polar lipid (IPL) show increased amounts of Ia and IIa, resulting in increased MBT'$_{5ME}$ values. The sediments deposited in a period of increased P influx (orange) show no distinct signal.

Lake Baldegg - Eutrophic - Seasonal anoxic watercolumn (artificial aeration)

Core collected at 21m water depth - Sediments anoxic below 0.1 cm blf - Max sediment age ~ 150 yr.

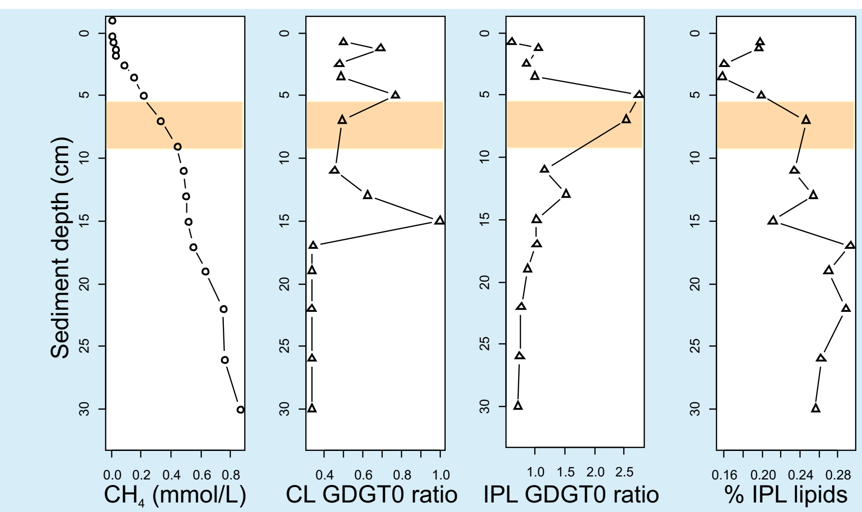


Although most microbial degradation of OM happens in top few cm (increase in TOC), the percentage of brGDGT lipids produced recently (IPL) increases in deeper sediments (>20 cm). This increase in % IPL correlates with an increase in brGDGT Ia (%) in the core lipid fraction.

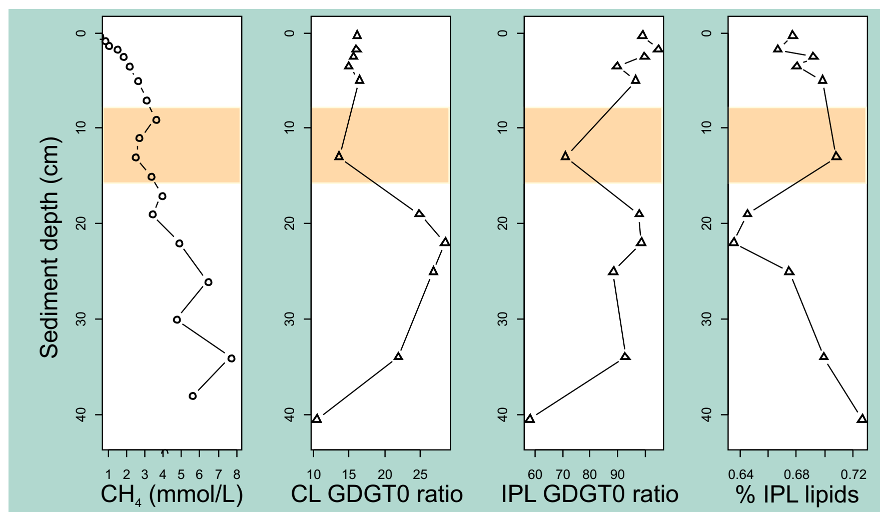
The distribution of core lipid (CL) brGDGTs changes downcore, with a decrease of brGDGT IIa (%). Sediment horizons with a decreased amount of brGDGT Ia (%) are encountered, resulting in variable MBT'5ME values. Compared to the CL fraction, the intact polar lipid (IPL) show slightly increased amounts of brGDGTs Ia, IIIa and IIIa'.

Proxy 2: Archaeal isoprenoid GDGT lipids.

In lake sediments, the presence of GDGT0/crenarchaeol values > 2, indicate the presence of methanogenic Archaea. Methanogens produce CH_4 in anoxic conditions, and will be more abundant in eutrophic lake settings.



Lake Luzern IPL and CL distributions show a distinct horizon of methanogenic archaeal activity. The IPL signature is present at more shallow depths (younger sediments) than the CL fraction. Sediments deeper than 17cm show an lipid distribution that does not reflect the presence of methanogens, although CH_4 concentrations continue to rise.



Lake Baldegg has high GDGT0/cren values, especially in the IPL fraction, that are typical for eutrophic lakes with a high methanogenic activity. A maximum is observed in sediment depths between 20-35 cm blf. In deeper sediments (>40 cm blf) the GDGT0/cren ratio drops, indicating a change in the archaeal community composition.

Conclusions

A clear subsurface maximum in brGDGT intact polar lipids is observed. This IPL signal will contribute to the total lipid extract when using standard high temperature extraction protocols.

The GDGT0/crenarchaeol ratio indicates subsurface methanogenesis at distinct sedimentary horizons.

Russell, J. et al., 2018. Org. Geochem. 117, 56-69.
Fiskal, A. et al., 2019. Biogeosc. 16, 3725–3746.