

Comment on bg-2021-232

Anonymous Referee #2

Referee comment on "Bacterial and eukaryotic intact polar lipids point to in situ production as a key source of labile organic matter in hadal surface sediment of the Atacama Trench" by Edgart Flores et al., Biogeosciences Discuss.,
<https://doi.org/10.5194/bg-2021-232-RC2>, 2021

Biogeosciences Review: bg-2021-232

Flores et al. provide a comprehensive survey of intact polar lipids from ocean floor sediments collected along the rim and within the deepest portion of the Atacama Trench. The diversity and abundance of the benthic lipidomes were further contrasted with that of the overlying 0-700m water column (with results published by Cantarero et al., 2020). This environmental baseline survey is then used to make inferences about the source and transport of lipids into the trench. This paper is generally well written (more so for the results and discussion). The data represent an important contribution.

Although, I am in favor of publication, I do not yet necessarily agree with the interpretation or rationalization of the described lipidome. From the paper's title to its conclusion is a focus of IPLs largely representing (or acting as) tracers or proxies of particulate organic matter (POM). While a component of IPLs may find its way into POM, these compounds say little about what POM is, how it comes to be preserved, or how it is transported through the water column. The OM instead comprised of all sorts of detritus (i.e. extracellular polysaccharides, fecal material, animal kills and falls, etc.).

Furthermore, the authors explain the similarities between the bathyal and hadal lipidomes as products of mass sediment transport, what they term as being lateral transport. First the term lateral transport is confusing as this could easily also mean transport across on latitudinal position within the base of the trough to another point at the base of the trough. Instead, I think the authors are referring to down slope sedimentation. Second, the basis for a lateral transport does not to me make sense based on the data that have been collected. Down-slope mass wasting events are episodic in space and time (even the V-shaped basins vary in slope from 8-10deg). The sediment depths to which the samples were collect are at the very surface layers (0-1cm deep and no more than 3 cm deep). So, if the kinetics show that upper water column inputs do not survive their direct transport to the seafloor, then how does an IPL survey as a sediment particle moving step-

wise down the trench slope? What sedimentary evidence do the authors have that the upper 3 cm of sediment at all of the sampled stations represents debris flows, turbidite, or mass wasting events? What is the slopes adjacent to all AT core sites? Can a model be made to show what the decent time would be for a bathyl sediment to reach the bottom of the trench?

More likely is that the microbial communities of the sea floor are not sensitive to the change in hydrostatic pressure and all things the same, thrive on a low nutrient supply from the upper water column – creating its own selective mechanism. As such the paper would be better served focusing on the important conclusions that it does resolve well. These are:

- This is an environmental baseline survey of bacterial and eukaryotic sourced IPLs.
- The most abundant ester-based IPL are phospholipids. Most of these have yet to be described.
- Bathyal and Hadal sediments have very similar compositions of ester-bound IPLs and therefore may indicate that these environments are host to the same microbial surface communities.
- Most IPLs that would be common to the upper water column appear to get almost entirely degraded during their decent to the hadal seafloor suggesting the highly labile lipids are derived from ocean floor microbial communities.

Lastly, I would suggest that some of the eukaryotic IPLs may represent fungi or metazoan type detritivor. That would be a interesting use of IPLs if this link could be constrained.

Minor Comments

Title:

Archaeal lipids do not factor into this study, so perhaps indicate this is a bacterial and eukaryote IPL survey. The choice of indicating labile organic matter is not something I think gives strength to this study. Please see above comments for more on this point.

Consider removing lateral transport.

Abstract:

Line 20 – 21: Change sentence to “Elevated organic matter (OM) concentrations are found in hadal surface sediments relative to the surrounding abyssal seabed. However, the origin of the biological material remains elusive.

From here on replace all instances of the term “organic matter” with the acronym “OM”.

Line 22: Replace “cell” with “cellular” and “in” with “extracted from surface sediments”.

Line 23: replace “depths” with “margin”.

Line 26 – 28: Unclear, please rewrite.

Line 29: Delete labile – all IPLs are labile lipid structures with some head group classes being more resilient than others.

Line 29 – 30: Does not fall out as to how that is necessarily so based on what is written.

Line 35: End sentence at ecosystem. Begin next sentence with Furthermore, they also...

The abstract does little to reconstruct the microbial diversity based on the recovered lipidomes as extensively discussed in the text.

Introduction

Line 41: delete “ocean”.

Line 42: delete “long-held”.

Line 44: Replace “In” with “For” and delete “while”.

Line 45: add "additionally" after pressure. And delete "the most" end sentence by deleting "compared to shallower habitats."

Line 46: Begin new sentence with "Availability" and move this sentence up in front of the prior one.

Line 48: Replace "However" with "To"

Line 49: Delete "A study by".

Line 54: Use POM.

Line 59: I would argue that all sources of OM spatially vary.

Line 60: Unclear. This is an over-simplification of the mass transport mechanisms and hydrographic processes at play in trench systems.

Line 62: Replace "bacterial and archaeal" with "microbial". Please also note that these surface sediments certainly contain abundant fungal communities.

Line 64: Missing references.

Line 67: Rewrite this section of the sentence.

Line 68: It is unclear what is really meant by the term redistribution in this sentence.

Lines 82 – 85: Too much detail.

Lines 85 – 86: Not only. Other head groups are common as well.

Figure 1. Could be greatly improved with a larger perspective map showing where along the Atacama Trench the samples survey occurred.

Line 90: Under these conditions, it is not the glycerol or acyl/isoprenoid tails that are labile, but the head groups of the lipid. Also I am not seeing the point of this sentence. How can you compare sources and preservation based on to higher break-down products? Much of these CLs form similar break-down products that cannot in themselves be untangled and linked to their primary sources.

Lines 102: Many things make up labile compounds that are not IPLs.

Line 107: It is a mischaracterization to consider IPLS as a proxy of OM loading to sediments. Microbes may hitch-hike on other forms of detritus (fecal material, extracellular polysaccharides, clay minerals, etc.), but they easily represent (and most commonly and simply do represent) what is the living or very recently deceased microbial components in the sediment. The very nature of applying a modified Bligh and Dyer extraction to get IPLs insinuates that these compounds are still attached as complete or partially degraded cellular membranes. If OM provenance is to be assessed from IPLs it must be done in combination with traditional techniques, be they hydrocarbon biomarker analyses, bulk rock sediment parametrization (TOC, HI, and OI) and/or FT-ICRMS POM studies.

Materials and Methods

Line 120: Indicate that this is bacterial and eukaryote IPLs.

Line 121: Delete "with 3 depth intervals each. This is better explained below.

Line 144: It is unclear why on three very shallow sediment samples (up to 3 cmbsf) were analyzed within a 60 cm core.

Section 2.2.1 Lipid extraction – Comment: Presumably the samples were immediately sectioned and frozen when removed from the multicorer? No details provided on this stage of sample collection and processing.

Lines 164 – 176: Make lower case the chemical names that do not start a sentence. Continue to follow this throughout the text.

Results

Line 262 – 267: Acronyms already defined in the text.

Line 385: Replace “test” with “evaluate”.

Discussion

Lines 429 – 431: Not needed and can be deleted.

Lines 717 – 722: Simplify this section.

Lines 723 – 724: Delete this sentence.

Line 741: Change to SQDG?