Reviewer 3

Paradis and co-workers have investigated the distribution and sources of organic matter in sediments from submarine canyons in the Gulf of Palermo, using a combination of bulk sediment properties, a suite of biomarkers, and (compound-specific) stable and radiocarbon isotopes. They find that surficial sediments in the canyons contain between 50-70% terrestrial OC, but that the source of this OC differs between canyons, where some canyons receive OC discharged by nearby rivers, and others receive OC from up-current sources. They also find that bottom trawling has a negative influence on the amount of OC preserved and promotes down-canyon transport.

The manuscript is well written, and the data that is presented is sound. The main remark I have on this work is the limited number of samples (n=7) and the lack of samples from local soils, river(bank) sediments, and marine algae or SPM to serve as endmembers in their calculations to determine contributions of terrestrial OC to submarine canyon sediments. Endmember values are now derived from the literature, and even though the authors used Monte Carlo simulation to compensate for this in their mixing models, the endmember assumptions still introduce uncertainty in the terrestrial OC estimations, and thus the importance on global scale carbon cycling.

We agree with the reviewer that one of the main limitations of our study is the limited number of sampled locations (7) and the lack of sampling of the local endmembers such as terrigenous sources (Oreto and Eleuterio rivers) and marine sources (marine algae or suspended particulate matter). To compensate this, we searched in the literature for the most appropriate end-member values based on their location and similar climate, soil type, and riverine hydrogeomorphology, leading to marine end-member values from the Gulf of Lions (Harmelin-Vivien et al., 2008), as well as terrestrial end-members from Catalan rivers (Sanchez-Vidal et al., 2013) and Sicily soils (Lawrence et al., 2020). We believe that these end-members are sufficiently, although not exhaustively, representative of the isotopic composition of OC in the study area.

Despite such a limitation, our approach is a substantial improvement to previous studies who take global average end-member values rather than local values (e.g., Di Leonardo et al., 2009, 2012; Pedrosa-Pàmies et al., 2013).

In addition, the relatively low number of samples limits comparison of terrestrial OC contributions to sediments inside and outside the canyons to assess e.g., sediment focusing, carbon sequestrations, or verifying dispersal patterns and tracing back OC courses.

We agree that the canyon-centric sampling strategy limits the conclusion of the distribution of OC across the Gulf, and we can only refer to the dispersal of OC in each canyon. However, comparison of heavy metal concentration inside and outside the canyons point to the sediment focusing capacity of these submarine canyons (Palanques et al., 2022), whereas the compilation of more data of sedimentation rates in the Gulf point to a general decrease in sedimentation rate with distance from shore only on the shelf, whereas these sedimentation rates then increase again in submarine canyons due to their funneling capacity.

In addition, comparison of $\delta^{13}C$, OC/TN, and $\delta^{15}N$ isotopic composition of surficial sediment in the submarine canyons with an adjacent surficial sediment sample from the open slope (Di Leonardo et al., 2009) actually reveals that the contribution of terrigenous OC inside the canyon is higher, pointing to the preferential transport of terrigenous OC into submarine canyons.

This has been added in the revised manuscript in section “4.1 Contribution of terrigenous and marine organic carbon in the Gulf of Palermo” as follows:

"Although no data of mass accumulation rate is available from the continental slope, the rapidly decreasing accumulation rates on the shelf with distance from shore (0.84 to 0.15 $g \cdot cm^{-2} \cdot yr^{-1}$) to values that are considerably lower than in submarine canyons (0.35-0.82 $g \cdot cm^{-2} \cdot yr^{-1}$) indicates that sedimentation rates on the adjacent slope will be considerably lower than in the canyon axis, as observed in other incised continental margins (Buscail et al., 1997; Sanchez-Cabeza et al., 1999; Masson et al., 2010; Paradis et al., 2018). Moreover, surficial sediment from a sediment core collected in the open slope between Oreto and Eleuterio canyons at 712 m depth did not present any sign of trace metal contamination, whereas sediment cores collected along the canyon axis had significant trace metal contents, indicating a preferential downslope transfer of sediment and pollutants into submarine canyons (Palanques et al., 2022). In fact, this same sediment core on the slope also presented higher $\delta^{13}C$ values (-22.7 ‰; Di Leonardo et al. (2009)), similar to marine end-member values, than those in the afore-mentioned canyons (-24 to -25 ‰), which tend toward more terrigenous end-member values. This further supports the notion that submarine canyons transfer terrigenous OC deeper and farther offshore than would occur in their absence.

The observed high accumulation of both marine and terrigenous OC in these submarine canyons confirms their role as important sites of OC sequestration, as shown in other canyon systems (Masson et al., 2010; Maier et al., 2019; Baudin et al., 2020). However, the contrasting accumulation of terrigenous and marine OC in each canyon suggests that even in closely spaced submarine canyons, the main source of the OC can greatly differ."

Specific comments:

L80: Replace Damsté by Sinninghe Damsté

Done.

L81: note that crenarchaeol is not often the most abundant isoGDGT in marine archaea, as its abundance is temperature dependent. At 'cold' sites, GDGT-0 will be more abundant than crenarchaeol.

We thank the reviewer for this clarification. Hence, we have modified the sentence to be more specific, as follows:

"BrGDGTs are generally found in soil bacteria, whereas isoGDGTs are common in marine archaea, with crenarchaeol often the most abundant isoGDGT in temperate environments (Sinninghe Damsté et al., 2002)."

L83: the first study to show brGDGT production in marine sediments is Peterse et al., 2009 Organic Geochemistry.

Thank you for this clarification. It has been included in the amended manuscript.

Method section: there is quite some information on contaminants in the study area, but this information is not further used in the discussion. Reconsider its necessity.

The information on contaminants in the study area (Section 2.1) has been removed to focus only on the sediment dispersal mechanisms in the canyon.

L134: This line mentions ‘naturally high sedimentation rates’. Can you add numbers to provide context? There are a few instances later in the manuscript where sedimentation rates are mentioned and can use some specification. Please check.

The natural sedimentation rates in the canyon axes have been added as follows:

> “This configuration facilitates the transport of suspended sediment from the shelf into Eleuterio Canyon, leading to naturally high sedimentation rates (0.52 cm·yr^{-1}) along its axis at 200 m in comparison to natural sedimentation rates in Oreto Canyon at the same depth (0.11-0.16 cm·yr^{-1}) (Paradis et al., 2021).”

L140: this is one of those locations: what kind of rates resemble ‘background sedimentation’?

The trawling-derived sedimentation rates in the canyons have also been added as follows:

> “The continuous contact of demersal fishing gear with the seafloor has contributed to sediment resuspension and its posterior transfer into these three submarine canyons, causing sedimentation rates to increase by up to an order of magnitude (0.21-1.38 cm·yr^{-1}) in comparison to natural (i.e., pre-1980s) background sedimentation (0.11-0.16 cm·yr^{-1}) (Paradis et al., 2021; Arjona-Camas et al., 2024).”

L172: …stable isotope RATIO mass spectrometer…

This has been corrected. Thank you for pointing it out.

L204: I appreciate that the authors assess the sources of brGDGTs even though the BIT index values they present are already very low (<0.05), indicating a primarily marine OC source. Note that the IIIa/IIa ratio used here to assess soil vs marine sources of brGDGTs is not supported by any biophysiological mechanism and also contains a temperature component by capturing part of the degree of methylation of brGDGTs.

Since the BIT index is already substantially low, indicating a primarily marine OC source, as the reviewer well points out, we have removed the calculation of the #rings$_{tetra}$ ratio and the IIIa/IIa ratio, since they don’t provide additional information. This way, the text is simplified and is easier to follow.

L206: Please add what the cut-off of 0.21 for #rings based on. The soil endmember for this ratio is generally based on #rings in local soils and likely differs per location/catchment.

As pointed out by the reviewer in the previous comment, the use of these additional proxies has been removed to simply the text. Instead, we simply focus on the comparison of the brGDGTs composition to the global database of soils and peats (Dearing Crampton-Flood et al., 2020).

L392: fraction of marine and terrestrial OC depends on marine primary productivity and export to the seafloor -> I fully agree with that. What can you say about marine production in the study area? After all, the Mediterranean Sea is known of its (ultra)oligotrophic conditions. Do you expect large contributions of marine OC at these sites? Especially in comparison to the other canyons mentioned in the text and possible influence of (high discharge) rivers?

Indeed, the Mediterranean Sea is oligotrophic in comparison to other continental margins, and this also affects the OC quantity and composition accumulating in Mediterranean submarine canyons in comparison to canyons incising other margins (e.g., eutrophic Portuguese canyons). This was further expanded in the revised manuscript:

"We acknowledge, though, that the fraction of terrigenous and marine OC deposited in continental margins also depends on marine primary productivity and the consequent flux of marine OC to the seafloor which is lower in the Mediterranean margin in comparison to other continental margins, leading to the accumulation of lower OC contents in Mediterranean continental margins in comparison to submarine canyons incising other margins (Pusceddu et al., 2010; Pasqual et al., 2011)."

L397: add numbers to the 'high sedimentation rate' at this site.

This has been added.

L401: I miss some discussion on the possible implications of different OC sources per canyon. Why does this matter?

The purpose of this study is to quantify the source of OC (marine vs. terrigenous) and, using biomarkers, identify the specific sources of marine and terrigenous OC. Finally, with a general understanding of the sedimentary dynamics of this Gulf, we also discuss the dispersal of OC and its transformation. Hence, we have structured the discussion as follows:

4.1 Contribution of terrigenous and marine organic carbon in the Gulf of Palermo

4.2 Sources of terrigenous and marine organic carbon in the Gulf of Palermo

4.3 Dispersal of terrigenous organic carbon in the Gulf of Palermo

Addressing all this is crucial to understand carbon cycling in marine sediments and the role of submarine canyons in accumulating different sources of OC. This latter aspect is essential to be able to distinguish between locally produced OC (marine OC) and allochthonous OC (terrigenous), which is important for carbon accounting purposes. In addition, distinguishing these sources can also serve to understand the preservation potential of OC in marine sediments, since marine OC tends to be more reactive than terrigenous OC. Hence, the latter will be more efficiently preserved.

The importance of OC source and preservation has been included in the manuscript by comparing them to protein turnover rates, a measure of OC reactivity (data previously given in the appendix, but not discussed in the manuscript). The following text has been added to section 4.1 of the discussion:

"Interestingly, the spatial distribution of OC sources is somewhat related to its reactivity, measured as protein turnover rates. Highest protein turnover rates were observed in Arenella mid-canyon, which had one of the highest marine OC fractions, whereas lowest protein turnover rates were observed in Eleuterio canyon head, which had one of the highest terrigenous OC fractions (Fig. S2c). However, other factors may also be contributing to the reactivity of OC (see section 4.3)."

L413: Thaumarchaeota are now named Nitrososphaerota.

This has been modified.

L428: ..age OF OC…

This typo has been fixed.

L435: I think the comparison of BIT index values can be a bit more nuanced. Also, Kim et al and Yedema et al only found high(er) BIT index values directly at the river mouth. After that, BIT index values decrease very rapidly with increasing water depth (e.g., Sparkes et al:

www.biogeosciences.net/12/3753/2015). A high(er) BIT index can only be found in coastal regions receiving substantial terrestrial input from rivers, which seems to be relatively limited at the shelf site included in this study.

Indeed, as mentioned in the text, the BIT index of surficial sediment in the Gulf of Palermo is substantially lower than in other continental margins that receive substantial input from rivers, which is why we also limited the discussion of this proxy to the fact that there is limited contribution of soil OC in the system.

L520: Make sure to not overstate the role of canyons in sequestering terrestrial OC when the study does not present data from sediments

To further justify the role of canyons in sequestering terrigenous OC, we now added data of the isotopic composition of the adjacent open slope at a similar distance from shore. This sediment core shows less depleted $\delta^{13}C$ indicative of lower contribution of terrigenous OC and a higher contribution of marine OC in comparison to sediments from the canyons, supporting our interpretation that submarine canyons have a higher capacity of sequestering terrigenous OC than the open slope. Unfortunately, sedimentation rates were not estimated in the open slope, but we can expect them to be substantially lower than in the canyon axes.