We thank the editor and both the reviewers for their feedback and helpful comments. We have revised the manuscript based on their comments.

- In the Introduction section, we have included explanations on focused vents vs. diffuse vents, the importance of studying secondary hydrothermal circulation and the challenges associated with it.
- Method section is reorganized to provide clarification on processing steps. In Section 2.2 (event detection and classification), we have incorporated details about the OBS network and added a sub-figure in Fig. 1, detailing broader geological context and the OBS network. We have provided technical details about preprocessing and events classification in section 2.2.
- We included a new Figure (Fig. 2) to the main manuscript comparing the waveforms and spectra of different types of events (Previously, type-1 event was shown in Fig. 1 and type-2, and type-3 events were shown in supplementary material).
- We provided explanations to interpret the broader spatial extent of the observed seismicity in Section 3.3 (potential source mechanism).
- We added details about the performance of the hydrophones network for detection of shallow earthquakes and provided future recommendations in the Conclusions section.

Reviewer A:

Please find below my review for the manuscript "Near vent seismicity at the Tour Eiffel vent site, Lucky Strike hydrothermal field, Mid-Atlantic Ridge" by authors Soumya Bohidar, Wayne Crawford, and Mathilde Cannat.

The authors present a one-year catalog of shallow microearthquakes very near the Tour Eiffel hydrothermal vent site at the Mid-Atlantic Ridge. The catalog is built using data from a novel hydrophone array, termed Hydroctopus. The authors adopt an event classification scheme, supported by a nearby ocean bottom seismometer network, to isolate shallow microearthquakes near Tour Eiffel from deeper volcanic events and whale calls. The authors consider multiple source mechanisms for these shallow, very small events, and conclude that anhydrite precipitation is most likely. The low event rate at Tour Eiffel sets it apart from the nearby Lucky Strike field, suggesting comparatively lower rates of anhydrite precipitation.

The manuscript is generally clear, focused, and well-written, but it lacks technical details and context for the importance of the work. Following revisions, this manuscript should be suitable for *publication. There are two sections below: more general comments followed by line-specific comments.*

The introduction would benefit from more explanation of why it is important to study secondary circulation. Specifically, some things that I wondered while reading the introduction that the authors might consider:

- *Why is understanding secondary circulation important: element/heat budgets in the global oceans, benthic community habitat, the formation of rare minerals, etc.?*
- *Why are observations thus far limited to TAG- is that only because that is where instrumentation has been located?*
- *Where else may secondary circulation be seen, but it hasn't yet been studied? Would we expect secondary circulation to be different at different spreading-rate ridges?*
- *Are there any studies of long-term changes in secondary circulation, and if not, what might we expect to see in relation to changes at mid-ocean ridges?*

➢ We have expanded the introduction sections explaining the importance of studying secondary circulation (lines 36-43).

➢ Studies of secondary circulation using geophysical sensors have so far been limited to the TAG hydrothermal field, primarily due to instrument specifications and the requirement for high sampling frequency data, which in turn demands greater battery capacity for long-term monitoring. We have explained this in lines 49–55.

➢ There is no long-term monitoring of secondary circulation so far, so we did not mention it in the main manuscript.

Some details on the OBS network should be added to Section 2.1, because it is used extensively in the support for the event classification section. The OBS network should also be added to Figure 1, allowing readers to understand the distance between OBS and Tour Eiffel, and changes in bathymetry between.

➢ We added details about the OBS network in Section 2.1 (lines 98-103).

➢ The OBS network is now shown on Fig. 1.

Section 2.2 requires more technical details, to allow reproducibility.

- *How is the hydrophone data processed prior to STA/LTA detection? Is it filtered, etc.?*
- *The authors only refer to the picking of P phases on the hydrophones. Are S phases ever recorded on hydrophones, or just quietly? Some context here would be helpful for seismologists who do not typically use hydrophones.*

- ➢ Bandpass filter (5-50 Hz) was applied to prior STA/LTA detection, and this is now included in line 107.
- ➢ Hydrophones measure the pressure variations and typically do not record S phase. Therefore, we only focused on picking direct P and reflected P phases in the hydrophones. Explanations regarding this are now given in lines 124-127.

Section 3.1 Event Classification also requires more technical details, to allow reproducibility.

- *It is unclear whether the classification of events into 3 different types is done manually, or automatically. What are the specific spectral requirements to separate detections into different types?*
- *Are fin whale calls automatically discarded? How is this done?*
- *Are there any events are detected by STA/LTA that are not classified as types 1-3 or whale calls? How is this dealt with?*

- ➢ Thanks to this comment, we provided a detailed description on event classification in section 2.2 (lines 110-118). We also added a new figure (Fig. 2) to the main article that compares the waveforms and spectra between the three different event types, recorded by both Hydroctopus and OBS.
- ➢ There were some events which could not fall under any of these categories or whale calls. We attributed them as ship/other ocean noise (mentioned in lines 159-161).

The authors need to fix the references to figure numbers and their captions in the supplement: for example, on Line 117, Figure S8 is referenced, but Figure S7 should be referenced instead; the caption for Figure S9 appears to refer to Figure S10 instead; the figure showing Type 3 events seems to be missing; etc.

- ➢ The supplementary figure numbers and their captions are now fixed.

The event classification process is an important approach presented in this work. The authors should consider adding a figure to the main manuscript that compares the waveforms and spectra between the three different event types, as recorded on both hydrophone and OBS, to help the reader understand how these events are distinct from each other. Much of this information is currently only available in the supplement.

- ➢ A new Figure (Fig. 2) has now been added to the main manuscript comparing all three types of events.

The authors should consider adding a panel to Figure 2 that shows the time series of types 2 and 3 events. I understand that the authors want to focus on shallow events, but this could help show that whale calls affect the overall catalog, and could help discuss connections between shallow and deep events. Are there any correlations between the time series of deeper, further events, and shallow events near Tour Eiffel (e.g. September 2016), or are the systems completely independent?

- ➢ We want to clarify that total number of type-2 (on-volcano deeper) events and type-3 (segment end) events detected by the Hydroctopus network may not represent their true number occurring during the experiment period. Compared to the OBS network (Fig. 1a) which is essentially designed to detect on-volcano deeper events, the Hydroctopus network can be considered as single station since its network aperture is much smaller (~ 150 m). Moreover, the STA/LTA parameters used here are adapted to detect short duration events only, which might exclude some type-2 and type-3 events. Therefore, we did not add the time series of type-2 and type-3 event to the main Manuscript, which might mislead the readers. We have clarified this in lines 205-209. A supplementary figure (Fig. S9) is present in the supplementary material showing the effect of whale calls on the overall catalog.
- ➢ The question of correlation between the time series of deeper, further events and shallow events is an important one: Any increase in the number of deeper on-volcano events is influenced either by magmatic and/or tectonic activity (Bohidar et al., 2024), and this must affect the occurrence of shallow events. However, we did not have a complete catalog of on-volcano events during the experiment from the OBS network. As mentioned above, catalog obtained by the Hydroctopus network may not represent their true number, so any correlation solely based on this catalog might be incorrect.

The conclusion/end of Section 3.3 could benefit from more context of the importance of the work. Some things the authors may consider:

- *What does this work add to the anhydrite literature overall? How does this compare/differ to other diffuse venting sites globally (or has only TAG been studied)?*

- *Presumably, one goal of this study is a proof-of-concept for the Hydroctopus array, but the performance of this system is not explicitly discussed in the conclusion. Would you recommend use of this technology elsewhere, and why?*

- Constraining the secondary circulation from locations of shallow microearthquakes has only been done at TAG other than our study at Lucky Strike vent field. We have compared our results to those of TAG site and provided reasonable explanations (lines 302-306).
- Performance of the Hydroctopus is now discussed in lines 307-311.

Line 5 – Crawford misspelled.

- We have corrected this (line 5).

Abstract – If the use of the novel hydrophone network is a main outcome of this study, the authors might consider more emphasis on that here.

- We have included this information in the abstract (lines 12-16).

Line 41 – How long-term is the OBS network? If this is the same OBS network that should be plotted on Figure 1, that should be referenced here.

- We have provided details about the OBS network in the Method section (lines 98-103) and included in Fig. 1.

Lines 96-97- it would be helpful to state how far away the OBS network is here.

- OBS network is present surrounding the volcano base (shown on Fig. 1).

Line 124- This is the first mention of S phases. Would be helpful to have already stated how OBS and hydrophones record these differently.

- We have now given information about S phase detection in the Method section (lines 124-127).

Line 129- Could also point out that it is a clear bimodal distribution, which helps support lumping the events into two distinct groups.

- This is mentioned in line 180.

Line 148 – Cite Figure 2 here.

- We have cited the figure here (line 204).

Line 154 – What about in September and May?

- We have included descriptions about the smaller swarms in September and May in lines 215.

Line 158 – What is the distribution of these uncertainties? Are there spatial patterns in uncertainties related to the geometry of the array or the bathymetry? Does this inform weaknesses of the technology?

- There are no spatial patterns observed in uncertainties related to the geometry of the array or the bathymetry. We included a supplementary figure (Fig. S10) showing uncertainties for all shallow events.

Line 159- It would be helpful to plot the scale of these average uncertainties in Figures 3a and b (not on each earthquake, but as a reference in the corner of the plot, etc.)

- The average horizontal uncertainties are now plotted in Fig. 4a.

Line 165- why aren't the July "swarm" events more clustered in space? This seems to contradict the statement that "the scatter of events appears to be real".

- Even if the July swarm events are not more clustered in space, they are not exactly scattered either and they tend to occur in the near Montsegur site.

Line 176 – different examples of the shallow earthquakes could be shown in a new waveform figure, as suggested above.

- A new figure (Fig. 2) was added showing different event waveforms and some more examples of shallow (type-1 events) are given in Figs S6 and S7.

Line 177- lacking S arrivals only on the OBS? Or do S arrivals show up for the other event types on the hydrophone?

- This is now clarified in lines 238-239.

Line 177- add a reference for this inference?

- A reference has been added in line 239.

Line 181- "No evidence for shallow magmatic injections" – is this because there are no earthquake swarms, or is this from other evidence?

- Lack of earthquake swarms from the OBS network data and no report of seafloor eruption during yearly site submersible surveys serve as evidence for no magmatic intrusions (lines 245-247).

Line 187- this run-on sentence is a bit confusing.

- This has been modified and is now written in two sentences (lines 250-254).

Line 200- does this preferred mechanism tend to lead to scattered locations, as is seen?

- The preferred mechanism for the observed shallow events is reaction-driven cracking in response to anhydrite precipitation from the diffuse fluid in veins and cracks. As diffuse venting is widespread in the Lucky Strike Hydrothermal field (Barreyre et al., 2012, Wheeler et al., 2024), it may lead to scattered locations of events (lines 267-269).

Line 209- "weaker hydrothermal circulation"; does this imply less focused circulation, leading to scattered locations?

- Here, weaker hydrothermal circulation implies less vigorous circulation in terms of heat flux of the focused vent (here Tour Eiffel vs TAG). As higher the heat flux of the focused vent, the entrainment of the secondary circulation is equally more vigorous and concentrated surrounding the focused vent. On the other hand, in weaker hydrothermal circulation, diffuse venting is more proficient and widespread. In Lucky Strike hydrothermal field, 95% of the heat comes from diffuse venting (Mittelstaedt et al., 2012). So, it is expected to have scattered locations of shallow 'proposed anhydrite precipitated' events at Lucky Strike compared to TAG.

- This section is reorganized and mentioned in lines 267-269.

Line 212- how does the depth limit of earthquakes compare to TAG, and what are the implications of this?

- This is described in lines 279-283.

Line 216- typo in spelling of anhydrite.

- We have corrected this (line 287).

Line 233- what about the OBS data?

- Availability of the OBS data is now mentioned in line: 314

Line 243- missing a number after "IPGP contribution"

- This line has now been removed.

Reviewer B:

In the paper "Near vent seismicity at the Tour Eiffel vent site, Lucky Strike hydrothermal field, Mid-Atlantic Ridge", Bohidar et al. detect and locate earthquakes near the Tour Eiffel vent site using hydrophone data from a novel experiment consisting of four closely spaced hydrophones connected by cables near the vent. The authors detect, classify, and locate earthquakes, estimate magnitudes, and perform waveform modeling to distinguish different types of events. This paper focuses on the "shallow" events. However, the definition of "shallow" events is not very clear. My major concerns relate to the clarity of the writing in the introduction and experiment design sections, the dimensions of hydrothermal circulation near the Tour Eiffel vent site, and the accuracy of the P-wave picks.

Major concerns:

1. ***Clarifications:***

The first paragraph of the introduction is somewhat confusing due to the use of multiple terms that are not clearly defined. Please clarify:

- *"focused vents" (Line 24) vs. "diffuse vents" (Line 29)*

- We have defined focused vents and diffuse vents in lines: 27-36

- *"secondary circulation" (Line 25) vs. "entrained circulation" (Line 27)*

- Secondary circulation and entrained circulation are essentially the same (now clarified in line 34)

- *The meaning of "diffuse fluids" (Line 27).*

- Definition of diffuse fluids is given in lines: 34-36

Please provide a clearer and more complete description of the experimental setup in Section 2.1:

- *What is the SEAMON node (Line 72)?*

- SEAMON is one of monitoring nodes of the EMSO-Azores seafloor observatory (now mentioned in line 92).

- *Include information on the deployment history.*

- The Hydroctopus network was first deployed in 2016. In every subsequent year, only the datalogger is recovered and reset, but the hydrophones remain in place. We report results from the first two deployments in this article (mentioned in lines 95-97).

1. *Event classification*

- *There appear to be mismatches between the text in Section 3.1 and Figs. S6–S9 in the supplement. One or more figures may be missing, making it difficult to follow the description.*

- The supplementary figure numbers and their captions are now fixed.

- *Line 113: Please define the term "duration" for type 1–3 waveforms.*

- Definition of 'duration' is given in lines 117-118.

- *Line 146: Are the 740 "shallow events" the same as the "type-1" events? Please clarify.*

- The 740 shallow events are the same as the 'type-1' events. This has now been clarified in line 211.

- *What types of events are shown in Fig. 3? Are they exclusively type-1 events? If 500 m depth is used as the threshold for "shallow" events (Line 144), some events in Fig. 3 appear much deeper.*

- Only shallow (type-1) events are shown on Fig. 4 (previously Fig. 3). We did not use any threshold depth value for shallow events, instead 90% of these have depths < 500 m. This has now been clarified in line 199.

- *It would be helpful to provide additional figures (similar to Fig. 3) in the supplement, showing the locations of type 1–3 events separately to illustrate their spatial distributions.*

- Locating type-2 (on-volcano deeper) events and type-3 (segment end) events with the use of the Hydroctopus network is beyond the scope of this study, because the network aperture of hydrophone network is very small, and most of these events would be present outside this network area. However, a general distribution of on-volcano deeper events can be seen in Bohidar et al., 2024 in which the on-volcano deeper events are located using the OBS network. Since we had only one operational OBS during this experiment period, we could not locate type-2 and type-3 events using the OBS network either.

- *Please elaborate on the waveform shown for the type-1 event in Fig. 1:*
- Type-1 event waveform (now shown in Fig. 2a) is described in lines 162-165, 183-186.

In Fig. 1c, what is the larger amplitude arrival after the P pick (peak at ~1.8 Pa)?

- The larger amplitude is the P pick. The initial pick has almost same energy level as the noise, therefore it is not the P pick. As we described in line 162, type-1 event is single phase which is the larger amplitude. We have now correctly marked in Fig. 2a.
- This was just an error while plotting and marking P pick in this figure. During all the processing part, P pick arrival time is directly taken from STA/LTA detection time which picks the largest amplitude arrival time only.

Does the P pick on N-OBS correspond to the weaker arrival currently labeled as P in Fig. 1c, or to the later larger amplitude arrival?

- ➢ The P pick on the N-OBS corresponds to the larger amplitude arrival. The P pick on the Hydrooctopus-1 has now been clearly marked (Fig. 2a).

Please label the location of the earthquake whose waveforms are shown in Figs. 1c and 1d.

- ➢ Event location for the example event (Fig 2a) is now shown in Figure 4.

In Fig. S6, are the larger amplitude arrivals the P waves? Do they correspond to the initial P arrival shown in Fig. 1c or to the later, larger arrival? Please label the P picks on these waveforms.

- ➢ The larger amplitude arrival is the P phase. P picks are labelled on Figs S6 and S7 now.
- *Overall, please clarify the accuracy of P picks for type-1 events.*
- ➢ The P picks are detected automatically using phase cross-correlation (lines 119-123).
- *The spectrum in Fig. 1b is somewhat confusing: at the time of the largest amplitude, the power b does not reflect this peak. Please consider adjusting the color scale of the spectrogram to avoid saturation at these times.*
- ➢ The event waveform and the corresponding spectrum are now plotted in Figs 2a-1 and 2a-2, and the largest amplitude coincides with the highest spectral energy arrival.

1. ***Dimension of Hydrothermal Circulation near Tour Eiffel Vent Site:***

- *The distribution of shallow seismicity appears to cover a much larger area than the diffuse vent area reported by Wheeler et al. (2024). Do any of the seismic events overlap with the known vent locations near the Tour Eiffel vent site?*

- *How do the authors explain the broader spatial extent of seismicity observed in this study compared to the vent distribution?*

- ➢ The diffuse vent area mentioned in Wheeler et al., 2024 focuses the diffuse vent area of the Tour Eiffel hydrothermal vent site only. Fig. 4c shows few of the events which are present in the immediate vicinity of Tour Eiffel vent site.
- ➢ However, diffuse venting is widespread in Lucky Strike hydrothermal field and contributes significantly to the total heat flux. There are other focused vents like Mont Segur, Y3 and

Sintra which are present at only ~70-250 m from the Tour Eiffel vent site. We therefore interpret that the broader spatial extent of the observed seismicity is due to widespread distribution of the diffuse venting in the Lucky Strike hydrothermal field. The secondary entrainment is caused by a broader hydrothermal upflow domain associated more with diffuse venting than with one single focused vent site like Tour Eiffel (lines 265-269).

Minor concerns:

1. *Line 38: Please label both the Lucky Strike hydrothermal field and Lucky Strike volcano in Fig. 1 to provide broader geological context.*

2. *Line 45: Include a reference to Fig. 1 when describing the structure of the Tour Eiffel vent.*

3. *Line 123: Label the N-OBS station in Fig. 1.*

4. *Fig. 1: Add a scale bar to the inset map.*

- ➢ We added a figure of the Lucky Strike volcano area (which was previously shown in inset map) in Fig. 1 with a separate color bar. N-OBS is marked in this figure. Reference to Fig. 1 is included in line 63 while describing Tour-Eiffel vent.