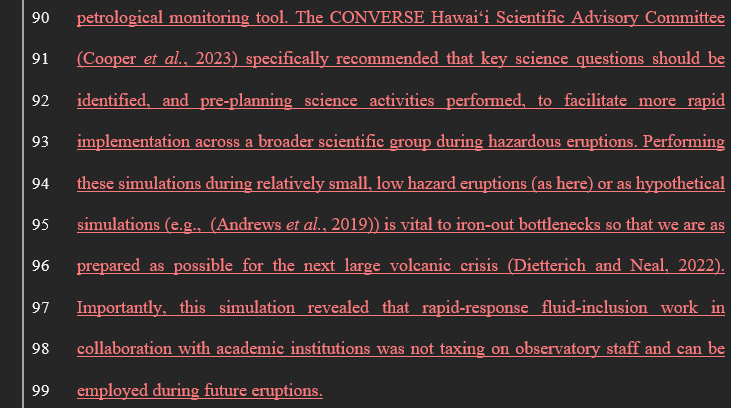
Response to reviewers

Reviewer: 1

Comments to the Author

The paper reports quick analysis of CO2 fluid inclusions by Raman spectroscopy to determine their density and pressure of entrapment in olivine for recent eruption of Kilauea. The main conclusion is that the analysis can be done relatively quickly (in 1-2 days) compared to usual time range of petrologic studies and therefore the results are valuable for near real-time petrological monitoring of active volcanoes.  
The paper is written clearly and the results are technically correct. I am however not supportive of this publication in Journal of Petrology because of several reasons, mainly because of limited scientific value of the quick data. I recommend to publish these results in more specialized journal like Bulletin Volcanology or similar.

We thank the reviewer for the appreciation of the quality of the data and manuscript; however, we respectfully disagree with the conclusion that there is limited value to the speed of the method. There are currently no petrological methods available that are capable to produce magma storage depth data within a single day of analyses – this is important because it is a timeframe that is relevant to observatories monitoring eruptions and provides a secondary independent check for geophysical data (which currently has no other validation than itself). The importance of such work has been emphasized by the Community Network for Eruption Response (CONVERSE), a close collaboration between observatories and academics. We now clarified this in the manuscript.



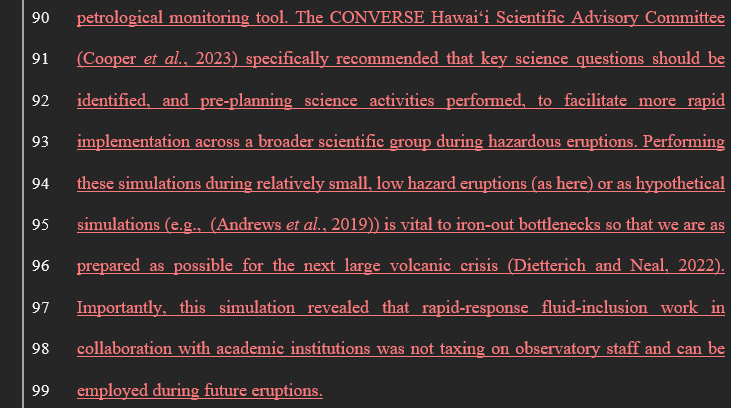
1) The methodological approach is well known. It does not even require high-resolution Raman spectrometer (=expensive instrument), it can be done with high precision using optical freezing-heating stage to record homogenization temperature of fluid inclusions. If the authors believe that joint well-coordinated work of small group of people is real innovation, I disagree with this. Even if the group can work in such regime during a week or month (can it?), this will not be scientific result.

We agree that the use of fluid inclusions to assess magma storage depths is not a new method as it has been used in deep storage systems in the past via microthermometry (we assess the reliability of the method in DeVitre and Wieser, 2024). However, we disagree that microthermometry can access this information in every case. Microthermometry is indeed very easy to conduct when the density of CO2 is above critical (where the vapor homogenizes into the liquid) but is extremely difficult to conduct in volcanic inclusions not hosted in quartz when the density is below critical, and the liquid homogenizes to vapor. This phase change is significantly more difficult to constrain and frankly impossible except for large inclusions hosted in clear minerals. This is well documented in numerous previous publications such as Hansteen and Klugel (2008). This means that pre-eruptive storage will only be constrained if it is happening at more than 7-8 km depth (in the case of Hawaiian volcanoes like Kilauea and Mauna Loa, all pre-eruptive storage is shallower than this). Microthermometry also requires the preparation of double-polished wafers, making preparation much slower than for Raman.

Concerning the sustainability of the analyses, we do not think that is a valid concern, part of what we have demonstrated is that this work can be done without “extraordinary” circumstances – participants still taught and attended classes, didn’t work overnight or conduct shift work. Now many of the slow steps have been ironed out, this could absolutely be sustainable for a prolonged eruption (akin to the work being done by the Icelandic geochemistry team). We agree that coordinating individuals is not an innovation, however, we have demonstrated and highlighted the feasibility of using this method as a near- real time monitoring petrological tool to determine magma storage depths. This is relevant because magma storage depth has been identified as high-value information for observatories (Re et al., 2021) but no petrological methods were able to access it on timescales relevant to eruptive crises. Also, while a number of papers have speculated that work can be performed on these timescales (Dayton et al. 2021, Zanon et al. 2024), this is the first study demonstrating it.

2) The real value of the quick data is not demonstrated. What happens is the data is obtained later, in a week or two? Or in a year? And by that time will be supported with other geochemical data, melt inclusions, olivine mapping etc.? I think the scientific value of the data will increase significantly.

We respectfully disagree with this statement. The value of quick data is to inform monitoring efforts and the decision-making related to those monitoring efforts. Observatories need real-time information, for example to assess whether populations should be evacuated. A sudden change in magma storage depth information can be a critical piece of information to understand an ongoing eruption. Magma storage depths have been identified by observatories (Re at al. 2021) as an extremely valuable piece of information in monitoring, but this is typically not a quickly produced type of information. There is no monitoring value to data produced a year later when an eruption has ended. At that point such data only informs models for “future eruption expectations”. We have added a new paragraph from our HVO collaborators emphasizing the value this information would give them during the next Hawaiian eruption.



3) The method requires good knowledge of temperature to calculate pressure using EOS for CO2 fluid. The dependence of temperature vs. olivine Fo-number is probably well known for Kilauea. However, it is necessary to demonstrate its long-term validity.

We respectfully disagree with the reviewer. One of the major advantages of the fluid inclusion method is that the CO2 EOS is remarkably unsensitive to entrapment temperature, and CO2 density is far more sensitive to pressure. This contrasts strongly with mineral thermobarometry, where P-T are closely correlated and difficult to deconvolve and melt inclusion solubility models which can show strong temperature sensitivity. We have included a plot showing how little the sensitivity of this method is to a “precise” temperature constraint (new Fig 1). In fact, even a ±125 K error on temperature (essentially encompassing the entire range of measured temperatures for olivine saturated liquids ever erupted and measured at Kilauea) would matter very little (no more than 20% difference in the worst case) and is easy to model using our method via Monte Carlo simulations. We’ve added further discussion on this matter at lines 74-84 of the tracked manuscript.

*“One major advantage is that the conversion of CO2 density to pressure is relatively insensitive to the choice of entrapment temperature, a parameter which may not be known at the onset of a new eruptive episode (Fig. 1a-b). The difference in pressure for EOS calculations considering the lower and upper limit of liquidus temperatures for olivine-saturated melts erupted at Kīlauea volcano throughout its history (~1100 and 1350 ˚C; (DeVitre and Wieser, 2024)) is at most ~20 %, which corresponds to ~0.2-0.4 km at depths representative of the Halemaʻumaʻu reservoir (1-2 km), and ~0.6-1 km at the depths of the South-Caldera reservoir (3-5 km; Fig. 1b and Fig. S3-S6). These errors are of similar magnitude to those associated with the conversion of pressures to depths through an estimate of crustal density (an issue affecting all petrological barometers). ”*

Anyway, quantitative analysis of olivine (=access to microprobe) is required. The temperature determination will be more problematic for less studied volcanoes and for more evolved magmas without olivine, which could experience more complex crystallization path.

Access to a microprobe is unnecessary – SEM EDS measurements have improved substantially in recent years, and our measurements of standards indicate that they are sufficiently quantitative for application of this method as we show in this letter. Additionally, the Fo-Temp relationship developed at Kilauea by DeVitre and Wieser (2024) could easily be developed at other volcanoes worldwide based on published data.

4) The method is hardly applied to magmas containing significant amounts of H2O because the fluid will be mixed H2O-CO2 fluid at low pressure and thus the pressure estimated from data on pure CO2 fluid will be the lowermost estimate. Thus, the method is difficult to apply for monitoring subduction-related volcanoes, which are often highly explosive and represent real danger for people.

We completely agree with the reviewer that this method is not applicable to arc magmas. We do not think a petrological method needs to be applicable to every volcano in every tectonic setting to have worth, or to be of interest to readers of the Journal of Petrology. For example, Amphibole thermobarometry/chemometry cannot be applied in MORB or OIB magmas. Clinopyroxene thermobarometry cannot be applied to Hawaiian shield volcanoes, which rarely erupt Cpx. Different tectonic settings and different volcanoes require different tools. Arguably, fluid inclusions are one of the most versatile tools, as they are insensitive to the composition of the host and have broad applicability to CO2-dominated magmas in MORBs and OIBs (e.g. Hawaii, Galapagos, Azores, Canaries, Iceland, Reunion, East African Rift). In fact, most volcanoes on Earth are H2O-poor basaltic volcanoes (75% of the volcanism on Earth is from Mid-Ocean Ridges alone, Crisp 1984), and numerous highly active volcanoes that do pose serious health and safety hazard to nearby populations are volcanoes for which our method is applicable and relevant (for example East African Rift, Iceland, Hawaii, Azores, Fogo in Cabo Verde, Canary Islands, Reunion Island just to mention a few). Many of these also have a history of explosive volcanism (including basaltic Plinian and sub-plinian eruptions). These systems also contain some of the largest and most active volcanoes in the world, and have captured the world’s attention with recent eruptions: 2018 Kilauea, 2021 La Palma, 2021-2024 Reykjanes activity, 2022 Mauna Loa.

It is also noteworthy that a recent paper clarifying errors in the original Duan and Zhang (2006) mixed H2O-CO2 EOS (Yoshimura et al. 2023, <https://doi.org/10.2465/jmps.221224a>) mean that we can now perform calculations to correct for the presence of H2O (not possible at the time of submission). We have corrected our data based on estimates of XH2O for Kilauea calculated from MI data (DeVitre and Wieser, 2024). The results are plotted on Fig 2. Overall, the correction is small (on average <10%) and does not change the results of our study or interpretations. The recalculated pressures do not shift the FI from one reservoir to another. We have also included details on the sensitivity of the method to XH2O contents in the new Fig 1.

When applying this method to other systems, similar corrections could be made based on melt inclusion data from previous eruptions, or even a reasonable estimate of the magmatic water content. We note that this is also not a problem unique to fluid inclusions – many mineral-melt barometers require the user to estimate the system’s H2O content.

To consider this comment, we’ve included a compilation of XH2O for different volcanoes and plotted this in Fig 4. We have added an entire section discussing the global applicability of the method (Section 3. Broader applicability of the method, lines 296-371 in the tracked manuscript).

In addition, collection of real time-series samples from explosive volcanoes in their active phase maybe very problematic.

For collection of real time-series samples, we do not think this is truly a valid concern as such sample collections are done in many places in the world using buckets, or even collecting on surfaces of solar panels (like during the dangerous explosive events of Turrialba volcano in 2016-2017). Additionally, we are not trying to make a method that is applicable to every eruption. Rather, one that is useful in many eruptions.  
5) Finally, I doubt that Raman analysis of fluid inclusions is more effective and precise approach than analysis of melt inclusions. Fluid inclusions are often very rare and search for them takes long time. Melt inclusions can be abundant and prepared for H2O and CO2 analysis very quickly by experienced personal. Anyway, no matter fluid or melt inclusions, there is still question what do tell us the estimated pressures?    
The first two authors on this paper are two experienced melt-inclusion analysts who have collectively published 6 first author papers on melt inclusions, and numerous co-authorships. Thus, we feel qualified torespectfully disagree with this statement. Melt inclusion analysis, no matter the experience of the user, is a very slow and expensive method. It is impossible to prepare **and fully analyze** as many melt inclusions (for example 16 in one day) as fluid inclusions and obtain magma storage depths. At minimum, Melt inclusion analysis requires constraining CO2 in the vapor bubbles using Raman spectroscopy or re-homogenization experiments (forward modelling is simply not good enough at this time), CO2 and H2O in the glass via FTIR or SIMS (if FTIR it requires double-polished wafers of the MI) as well as glass and host chemistry via electron microprobe followed by PEC corrections, total CO2 reconstructions, and solubility model calculations. It does not matter the experience of the melt inclusionist – it is impossible to conduct meaningful melt inclusion analysis in a timeframe even remotely comparable to fluid inclusion analysis.

In terms of precision and accuracy of measurements of FI vs MI, we also disagree. Suffice to looks at error analysis in Tucker et al., 2019; Hanyu et al., 2019, DeVitre et al., 2023 and Wieser et al., 2021 🡪 errors on melt inclusion analysis are frequently 20-50% or more; again, this is enormous compared to the precision of fluid inclusion analysis (even with entrapment temperature errors of >100K). We show the reliability of fluid inclusion analysis compared directly to melt inclusion analysis in our in-press paper (DeVitre and Wieser, 2024).

Lastly, regarding the abundance of melt inclusions vs fluid inclusions, we also find this to be inaccurate. It is not uncommon to find fluid inclusions and often even in the same crystals as melt inclusions. For this particular eruption, we found about 1 fluid inclusion bearing crystal for every 3 crystals polished. This is not any rarer than finding suitable melt inclusions for analysis.

Are these pressures of magma storage depth, or the inclusions were trapped on the way to surface?  What does mean the range of pressures estimated?

It has been shown extensively that FI tend to record stages of equilibration such as stalling and storage events (i.e., Hansteen and Klugel, 2008) and that clustering of pressures is indicative of such regions. It is possible that some of the inclusions could be trapped upon ascent (for example those that are very shallow and contain SO2) – but this would likely only be inclusions very close to the edge of crystals, or in secondary fractures that traverse the entire crystal as the crystals would have very little time for growth and annealing – these can generally be removed from the dataset (we filtered as possible). We note that FI and MI at Kīlauea record the same pressures (DeVitre and Wieser, 2024) within error of the methods, and that the depths estimated from our FI method are consistent not only with the MI data but also geophysical estimates of magma storage at Kīlauea – therefore we consider that this the most likely petrogenetic history that they are recording.

As for the range of pressures recorded, there are two main interpretations (aside from some of the distribution being explained by the uncertainty of the method): one is that re-equilibration of fluid inclusions between the 3-5 km reservoir and 1-2 km causes a distribution of pressures – however our re-equilibration models at Kīlauea (DeVitre and Wieser, 2024) indicate that re-equilibration is not of concern and that even a stalling event of ~2 years prior to eruption would result in <10 % difference in the pressure (this is less than the uncertainty of the method). Magma storage systems are not perfectly uniform molten magma chambers at a precise depth– rather they are mush systems, as such, it isn’t inconceivable that pressure and temperature are not uniform either, hence that FI trapped in crystals at slightly different locations in the system would have slightly different pressures. Random sampling of this system and a lack of significant re-equilibration could explain such a distribution. Clustering between 1-2km would simply indicate this is the predominant region of equilibration which we interpret as magma storage. Details of the method are discussed extensively in our GPL paper and are beyond the scope of this article.

How the data can be used by decision makers?

The results presented in this letter are the first demonstration that petrologically derived magma storage depths can become part of an observatory’s toolbox, with implications extending well beyond the academic sphere and bearing a direct impact on people's lives. Observatories having more information upon which to make informed operational decisions will directly impact the lives and livelihoods of individuals residing near active volcanoes, such as those surrounding Kīlauea volcano in Hawai‘i. Information can also bring comfort during volcanic events – for instance, during the devastating 2018 Lower East Rift eruption, Hawai‘i Island residents routinely asked questions related to the source of the erupting magmas and were expecting answers from the Hawaiian Volcano Observatory (HVO). We anticipate that near-real time Raman analyses of fluid inclusions will be used during future Hawaiian eruptions in concert with HVO’s current bulk rock XRF chemical monitoring routines. This will allow information about melt properties such as viscosity and temperature to be specifically tied to the reservoir supplying the melt. Time-series analyses of fluid inclusions would be particularly powerful for identifying a switch to a different magma supply. This fluid inclusion method can be applied to many hazardous and frequently erupting volcanoes worldwide (e.g., those in the Galápagos, Réunion, Azores, Canary Islands, Iceland, Cabo Verde), either through the development of in-house Raman facilities, or collaboration with academic institutions. This is particularly true given that resources required are modest, both from the perspective of instrumentation and personnel-hours. Making this method available to the community in a timely manner is particularly important in the present context, with the continued unrest and inflation at Kīlauea and the escalating activity in Iceland.

Taking all the comments together, I doubt that the contribution has sufficient scientific value for publication in Journal of Petrology. It may however have value for volcano monitoring. This needs to be demonstrated by doing this work over some time, not necessarily with the same intensity as in the reported case.  More specialized volcanological journal would be more appropriate place for this publication.  
We respectfully disagree with the reviewer on their conclusions. We have done careful work comparing microthermometry and Raman, and MI and FI pressures at Kilauea which is reported in our paper in GPL (DeVitre and Wieser, 2024). This proved the reliability of the method. The purpose of this study in turn was to show its viability as a rapid petrology monitoring tool – which we think has been accomplished as well and that had never been shown quantitatively before  
  
Reviewer: 2  
  
Comments to the Author  
Review on  
  
DeVitre et al Depths in a day - A new era of rapid-response Raman-based barometry using fluid inclusions.  
  
DeVitre and coworkers provide a time-efficient tool to get an estimation for the pressure and temperature of origin for the olivines in tephra related to the 10 September 2023 Kilauea eruption. I am a fluid inclusionist and hence I fully agree with the effectiveness and significance of inclusion studies as it is highlighted in this manuscript. I have also experienced in many cases the wide spectrum of the applicability of melt and fluid inclusion studies. However, a careful investigation is a must that does not help the time efficiency the authors point out here.  
We thank the reviewer for their appreciation of our method and results.

I have therefore several comments/concerns about the results, the results and implications about the study.  
  
1) The exact compositions of the fluid inclusions. The authors clearly state that out of the CO2, minor SO2 (less than 5 mol%) has also been detected at the temperature of analyses (around 40 °C).  However, especially in the case of low-density fluid like in this study, a careful investigation should be made by Raman spectroscopy to look all the potential fluid molecules that can be present in volcanic gases, like: N2 (taking care of air contamination), H2S, CH4, CO; most importantly H2O. For this latter case, to detect the water, a heating experiment at around 150 °C can be a useful approach (Please see Berkesi et al., 2009, Journal of Raman spectroscopy, <https://doi.org/10.1002/jrs.2440>), as at lower temperatures, small amount of H2O can remain undetected in fluid inclusions.

We agree with the reviewer that other fluid can be present in fluid inclusions, especially at shallow depths and that FI should be monitored for this. Via Raman spectroscopy, we did not observe any other gases than the ones mentioned (CO2 and occasional small amounts of SO2). N2, CH4, CO and H2S were not observed in any inclusions. This can easily be systematically monitored during analysis by collecting a broad raman spectrum encompassing all the regions needed to identify such gases (many of which have higher interaction coefficients than CO2, making small amounts easier to detect than CO2 even with short acquisition times). H2O can indeed be an important fluid. There are two approaches: one as the reviewer mentioned is to measure the FI while heating at around 150C but the caveat is that in many cases the H2O may have diffused out or reacted such that the left-over fluid does not contain any H2O anymore. The other approach (Hansteen and Klugel, 2008) is to correct for H2O, considering XH2O in the fluid and using a mixed CO2-H2O equation of state. DiadFit now has the capabilities to perform this H2O correction. In many cases this XH2O can be approximated using a solubility model and any existing MI data for the volcano – even if it is glass only MI data (this will provide a worst-case scenario) (DeVitre and Wieser, 2024). We have added a section discussing this in the text (Section 3. Broader applicability of the method). We emphasize that this method is not proposed for use in arc settings where XH2O could be very high. To further address this concern, we corrected our fluid inclusion pressures (shown on Fig 2d, this does not affect our results) and we also show the sensitivity of the method to XH2O contents in the new Fig 1.

2) In agreement with the previous point, I recommend the authors to add (at least to the supplementary) representative Raman spectra of the fluid inclusions analyzed. This would be very helpful to convince the reader about the fluid composition. Composition of the fluid, therefore, is crucial to check whether the distance of the Fermi diad on the CO2 Raman spectra can be applied to density-pressure-depth estimation. Given that the CO2 densimeters are calibrated to pure CO2 system, a careful investigation must be made as the components beside CO2 can modify the results on depth estimation as well. Please add more details on this subject to the manuscript.  I was also wondering why the author did no use Raman CO2 densimeters like the Fall et al., 2010 GCA (<https://doi.org/10.1016/j.gca.2010.11.021>), or Remigi et al., 2022 JRS (<https://doi.org/10.1177/000370282098760>)?

All raw spectra of our FI were provided in the data repository. Because we already conducted an in-depth analysis of FI at Kīlauea (DeVitre and Wieser, GPL in press), and surveyed the Raman spectrum for presence of other species, we are confident that the only species present in this case are CO2, <10% H2O, and rare small amounts of SO2. We agree that it is important to consider this however – and therefore include a more detailed discussion of the importance of surveying for other fluid species while conducting these analyses. We correct pressures using DiadFit for the likely presence of H2O (although it was not detected in the FI) based on the XH2O estimated from MI data at Kīlauea.

Concerning why we did not use Fall or Remigi, this is because the use of literature densimeters calibrated on different instruments than our own is inappropriate (LaMadrid et al., 2017; DeVitre et al., 2021; Devitre et al., 2023) and alone can account for errors on measured densities of up to 0.15 g/cm3 (catastrophic). Therefore, we built our own densimeter calibration at UC Berkeley using an apparatus of the same construction as DeVitre et al., 2021. This calibration is specific to our instrument and a comparison of densities measured by microthermometry and our Raman (they are within 5% of each other) is presented in DeVitre and Wieser, (2024, GPL).  
3) The temperature was used for crossing the CO2 isochors. The authors state that 1150 C was set as temperature of entrapment of the inclusions. Please provide more details to convince the readers why did you chose such a value?

We now provide more details on the choice of entrapment temperature, however we note that this is based on chemistry of Kīlauea magmas and geothermometric data from past eruptions like 2018 LERZ which in general indicate that 1150~ is a reasonable ballpark (DeVitre and Wieser,2024).

*“One major advantage is that the conversion of CO2 density to pressure is relatively insensitive to the choice of entrapment temperature, a parameter which may not be known at the onset of a new eruptive episode (Fig. 1a-b). The difference in pressure for EOS calculations considering the lower and upper limit of liquidus temperatures for olivine-saturated melts erupted at Kīlauea volcano throughout its history (~1100 and 1350 ˚C; (DeVitre and Wieser, 2024)) is at most ~20 %, which corresponds to ~0.2-0.4 km at depths representative of the Halemaʻumaʻu reservoir (1-2 km), and ~0.6-1 km at the depths of the South-Caldera reservoir (3-5 km; Fig. 1b and Fig. S3-S6). These errors are of similar magnitude to those associated with the conversion of pressures to depths through an estimate of crustal density (an issue affecting all petrological barometers).”*

The temperatures were refined after EDS analyses. This is clarified at lines 204-214 of the tracked document: “For the first and second days, we assumed an entrapment temperature of 1150 ˚C for all fluid-inclusions, based on geothermometric estimates of previously erupted liquids (Gansecki *et al.*, 2019; DeVitre and Wieser, 2024). On day 4, we calculate entrapment temperatures for each fluid-inclusion using the host forsterite content measured by EDS (DeVitre and Wieser, 2024), yielding temperatures spanning 1182–1307 ˚C. The average error induced by our initial assumption of 1150 ˚C is only ~7% (with a maximum offset of only 12 %). While crystallization temperatures at Kīlauea are relatively well constrained relative to other volcanic systems, using similar regression methods to those employed by (DeVitre and Wieser, 2024) relating liquid compositions to host olivine contents, it should always be possible to constrain temperatures within ~100 K at different volcanic systems using host mineral chemistry. ”

4) The quality of petrography images is poor, especially the optical microscopy images. Based on my experiences the routinely used microscopes provide better images than what the author show here (etc the Nikon OptiPhot2 optical microscope equipped with a Nikon CoolPix DS-Fi1 camera). Normally, we use a special condenser that is perfect for inclusion-seeking. For image quality, for example, please see figure 1 in Guzmics et al., 2019, <https://doi.org/10.1130/G46125.1>)  I don’t see the reason why you didn’t use such a properly working, routinely used optical microscopes equipped with a suitable camera instead of your smartphone-assisted technique?

We own high-quality microscopes and cameras for fluid inclusion analysis – however the purpose of the images attached was not to provide high-quality optical microscopy images of the FI but rather to navigate on our instruments for analysis (Raman and SEM). The reason we present these images is to show that to find the inclusions on the Raman and SEM (after they have been selected for analysis), high-quality microphotographs are not necessary. The reason this is relevant is because petrography microscopes and cellphone cameras are much more accessible from an economic perspective. All detailed images of the fluid inclusions are provided in the data repository. The images in the supplement were simply examples of how we can navigate on our instruments without needing such high-quality images.

5) There are some images where I can clearly see that the inclusions are primary (I think of the clearly isolated or randomly distributed inclusions). This is crucial for the implication. There are however inclusions where I see inclusions trapped along a fracture. Are these inclusions secondary or pseudosecondary? The pictures must clearly indicate this information, as in my view secondary inclusions should be avoided in this study.

We agree that it is relevant information, but it can be assessed from the current images.   
6) Despite their low quality, what is clearly seen on the petrography images (transmitted light mode, focusing on inclusion) is that there are melt and fluid inclusions co-entrapped in the olivines. The melt inclusions seem to be glassy containing a bubble phase, the fluid inclusion -as confirmed by Raman spectroscopy by the authors – are vapor-rich ones. May the data of pressure and temperature provide the exsolution of fluid phase from the melt in the magma chamber? Can this “bubbling” process of the magma be related to the eruption somehow? Please discuss it.

We are not sure we follow the point of the reviewer. Certainly, some of the melt inclusions are likely to have co-entrapped a fluid (having already exsolved a fluid phase from the melt and co-entrapped both melt and exsolved fluid), but the majority of vapour bubbles within melt inclusions at Kilauea form as a result of post-entrapment crystallization of an initially homogeneous inclusion during extensive cooling (see discussion by Wieser et al., 2021 for LERZ 2018 eruption). The ‘bubbling’ results from crystallization of denser olivine on the walls of the inclusion during cooling, which reduces the internal pressure. The relation to eruptive processes is that the host crystal has cooled, but this can already be deduced from the fact the host Fo content is far higher than the equilibrium content calculated from the matrix glass. Since CO2 starts exsolving very early and deep in Hawaii (likely 30-50km+), the pressure and temperature recorded by the FI will not be that of first exsolution, but instead the pressure at which the crystal grew and trapped the fluid. Therefore, I do not think that there is meaningful information that can be related directly to the eruption in this case.

There are some issues raised here, but I believe that once the authors clarify convincingly these above points then the manuscript can be accepted. For this, a major revision is needed in my opinion.  
I have attached the annotated pdf of the main text including some minor comments

We have addressed the comments. See screenshots below and attached pdf.

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

A screenshot of a black and white text

Description automatically generated

A screenshot of a chat

Description automatically generated  
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Márta Berkesi