

Dear Prof. Zellmer and Prof. Humphries,

We are grateful for your handling of our manuscript entitled 'Depths in a day - A new era of rapid-response Raman-based barometry using fluid inclusions' (ID JPET-Nov-23-0174). We have significantly revised the manuscript making use of the fact our original submission was well under the word limit to include a global assessment of the feasibility of fluid inclusions and have also provided a strong rebuttal to many of the reviewer comments, which we believe were ill-informed/incorrect. Thus, we would like to request that you reconsider the article for publication in JPET considering these revisions and rebuttal. We describe these changes briefly below, and in more detail in the response to reviewers (attached to the submission as a supplement file, as there was no other option in the system). We've also included a tracked changes version of our revised manuscript and Supplementary Appendix.

1. Method is not applicable in H₂O-dominated systems, where the fluid is not CO₂-rich.

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. Hawai'i, Galápagos, Azores, Cabo Verde, Canary Islands, Iceland, Réunion). These systems are some of the largest and most active volcanoes in the world and have captured the world's attention with recent eruptions: 2018 Kīlauea, 2021 La Palma, 2021-2024 Reykjanes activity, 2022 Mauna Loa. Basaltic CO₂-poor eruptions have also resulted in significant human impacts in the past (e.g., Laki, Iceland), and likely will again. To rebut this concern, we have compiled a global dataset of melt inclusions to determine the relative proportion of CO₂ and H₂O in the fluid phase at different volcanoes around the world. This is the first compilation of its kind and allows rigorous assessment of the utility of this method at many of the most hazardous volcanoes around the world. We have also added a section in the text discussing the effect of H₂O, a new figure (Fig. 1c-d), and recalculated pressures considering the effect of H₂O (shown on Fig. 2d)- showing the relative insensitivity of the method to the H₂O content of the fluid.

2. Method is very sensitive to temperature through the equation of state:

The reviewers expressed concern about the need for careful understanding of temperature, and how this might not be constrained in other systems. However, we disagree that this is an important variable – 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. For example, even considering a very wide range of plausible temperatures in Hawaii (1350-1100 °C), temperature only induces an uncertainty of ±10%. We include a new figure demonstrating just how temperature insensitive the EOS is (Fig. 1a-b). We do not feel there is any volcanic system on Earth which is poorly understood enough and without analog with well-studied systems that temperatures could not be estimated within a far smaller range based on mineral compositions. The olivine thermometer we use here would not be difficult to adapt for other systems with any literature data at all.

3. Method is not new, can be done with Microthermometry.

Reviewer 1 said that the measurements could be carried out with Microthermometry instead. However, it is well documented in the literature that microthermometric constraints on CO₂ density are not feasible on fluid inclusions with the low densities examined here, which dominate at many of the most active volcanoes around the world. While very low densities may be possible to measure in quartz where the fluid inclusion contains significant H₂O (which facilitates the observation of the phase change), no one has ever managed to conduct, and thus publish such measurements in olivine. Prior to the Raman technique being developed, no one had investigated upper crustal magma storage using fluid inclusions in Hawai'i (except from mantle and lower crustal xenoliths), despite it being one of the most popular areas in the world to conduct petrological research. Published fluid inclusion work using Microthermometry was focused on the Atlantic island chains dominated by deeper storage. In a recent paper (DeVitre and Wieser, 2024 GPL), we discuss in detail the pros and cons of the Raman vs. Microthermometric method.

4. What is the value of doing it quickly?

The reviewers criticized the need for rapid data. However, the Community Network for Eruption Response (CONVERSE), a close collaboration between observatories and academics, has highlighted the operation value of petrological research at numerous points. Additionally, this study was performed in close collaboration with Hawaii Volcano Observatory, precisely because this information has clear value for their operations during eruptions (see also Gansecki et al. 2019). They encourage academics and observatories to test workflows during times of quiescence, so the community is better prepared to respond when the next large eruption occurs. We believe this work will provide an excellent example in the literature of such a 'stress test', motivating additional work in other systems. We have added a paragraph directly addressing the value to observatories and communities in more detail. The purpose of doing this exercise at Kīlauea was to demonstrate its speed and validity in the context of a well-understood volcanic system, where the stakes were relatively low.

We have addressed these comments in detail in the response, and we believe the expanded version of the manuscript will clarify our position on the value of this method.

Thank you for your time and best regards,

Dr. Charlotte LJ Devitre and Dr. Penny E. Wieser