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Rapid assessment of magma storage depths: insight from fluid and melt inclusions from the 2018 Lower East Rift Zone eruption of Kīlauea.

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Determining the depths and conditions of magma storage is crucial to interpreting signals of unrest in the build up to eruptions. Recent work has suggested that gaining an understanding of the magmatic plumbing system during an eruptive episode can be vital to help predict changes in eruptive style and vigor [1]. However, popular petrological tools for determining magma storage depths are too slow and costly – at present, all estimates of magma storage depths have been determined after the eruption ended. For example, [2] and [3] present melt inclusion saturation pressures from the 2018 eruption of Kīlauea. However, the results of these studies were only published ~2 years after the eruption ended, making MI work unsuitable for real-time monitoring. Mineral-melt barometry can be performed more quickly, but is associated with far larger uncertainties. In contrast, CO_2-rich fluid inclusions (FIs) trapped within crystals have the potential to be a very precise and accurate barometer, because of the close relationship between CO_2 fluid density and entrapment pressure defined by an equation of state. Traditionally, the density of FIs has been determined by observing phase transitions using specialized heating and cooling stages.However, recent advances in the precision and accuracy of widely available micro-Raman spectroscopy offer a fast and cost-efficient method for measuring FI density with minimal sample preparation. We collect new FI data from 3 samples erupted during the 2018 eruption of Kīlauea (Late May, July and August 2018), and compare these to published MI depths from the same samples to evaluate the accuracy and efficiency of Raman-based fluid inclusion barometry. We analyzed and processed data from ~130 FIs contained in ~60 olivine crystals by calibrated Raman spectroscopy [4] in less than 15 days (~5 days per sample). Our results indicate that FIs record pressures consistent with MI saturation pressures while only requiring a fraction of the work, time, and resources of MI work. Our work shows the potential of Raman-based fluid inclusion barometry as a reliable and efficient tool for monitoring during volcanic crises.

[1]Gansecki et al. (2019,10.1126/science.aaz0147)

[2]Lerner et al. (2021,10.1007/s00445-021-01459-y)

[3]Wieser et al. (2021,**10.1029/2020GC009364**)

[4]DeVitre et al. (2021,10.1016/j.chemgeo.2021.120522)