Olivine barometry based on X-ray computed tomography of fluid inclusions

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High resolution X-ray computed tomography (HRxCT) can identify and measure the volume of fluid inclusions in olivine phenocrysts. We apply this technique to ocean island basalt (OIB) phenocrysts from the Samoan archapelego. Ninety percent of the total CO_2 and helium in each mineral separate resides in <15% of the phenocrysts, so selecting gas-rich grains for analysis provides major analytical advantages for noble gas isotopic analysis. For instance, we can reliably extract enough helium for isotopic characterization by crushing single gas-rich grains, which has revealed isotopic variability among olivines in individual OIB samples on the order of several Ra. This should be taken into account when considering the extreme helium isotopic variability in ocean island settings.

The fluid inclusion volumes measured by HRxCT—coupled with the measurement of CO_2 released during single-grain crushing—allow us to calculate an average fluid inclusion entrapment pressure for each phenocryst. By linking gas geochemistry to certain stages of magma ascent, this new barometric technique promises to shed light on degassing and volatile mixing processes beneath ocean islands volcanoes.