A new crushing technique for coupled $\delta^{13}C$ and $\delta^{18}O$ analysis in fluid inclusions

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Determining the composition of CO_2-rich fluids trapped in crust- or mantle-derived minerals is crucial to understand the cycling of volatiles between Earth's deep and surficial reservoirs. Analysis of carbon and oxygen stable isotopes in particular can be used to estimate the relative contribution of different fluid components and the effect on carbon budgets.

A new crushing method for analysis of coupled C-O stable isotope compositions in small amounts of CO_2 (sub nmol) from fluid inclusions is presented. The technique is based on the in-house developed Amsterdam crusher Device [1], previously used for analysis of $\delta^{18}O$ and $\delta^{2}H$ in fluid inclusions in speleothem calcite. We evaluate accuracy and reproducibility of the techniques by analysis of CO_2-rich quartz from: 1) UHT-Bakhuis Granulite Belt (Suriname) and 2) Val Nalps (Switzerland). The ultimate aim is to apply the technique to CO_2 bubbles in olivine-hosted melt inclusions (MIs), to study recycling of volatiles in subduction zone.

The Amsterdam crusher Device is connected to a Gas Bench II equipped with a cryotrap unit to collect the liberated CO_2 gas. Crushing is achieved by applying pressure with compressed air to the piston inside the crusher. The liberated CO_2 is carried in He to the Delta *Plus* isotope ratio mass spectrometer (IRMS). The sensitivity and reproducibility of the method is determined by injecting CO_2 standard reference gas into the crusher. Injections of 9^{-10} mole of CO_2 yield 3V of amplitude (m/z=44) and reproducibility of $\delta^{13}C$ is 0.24‰ (SD, n=7). The results from crushing small amounts of quartz veins (4 mg) show $\delta^{13}C$ values in good accordance with the mantle (~7 ‰), but rather dissimilar value of $\delta^{18}O$. Preliminary data on CO_2 released by crushing olivine containing CO_2 bubbles in MIs indicate that adsorption processes affect sensitivity and accuracy.

The new continuous-flow crusher technique for C-O isotope analysis of fluid and melt inclusions is relatively quick compared to in vacuo techniques and can readily be applied to determine carbon isotopes from CO_2 in quartz, to evaluate mantle outgassing/fluid cycling within the crust.

[1] Vonhof, H. B. et al. (2006) Rapid Communications in Mass Spectrometry 20(17), 2553-2558.