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In situ laser microprobe technique for carbon and oxygen isotope analysis of carbonate

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Microprobe analysis is one of major methods for development of isotopic measurements. The traditional method for carbon and oxygen isotope analysis of carbonate is phosphoric acid decomposition to carbonate powder in a vacum tube. This method is widely accepted for the reasons of ease and stability, however, it requires large sample sizes (tens of milligrams) and each sample must be prepared by hand. Online sample preparation and continuous-flow isotope ratio mass spectrometry (CF-IRMS) are now widely applied analytical techniques for the precise measurement of carbonate samples as small as 50 μg (even to 20 μg). However, these methods can not meet the requirement of high-resolution in situ analysis.

In situ laser microprobe techniques for stable isotope analysis of carbonate were developed in the 1980s; the carbonate minerals were decomposed into CaO and CO_2 gas with the infrared laser. However, this method was hampered for the reason that oxygen isotopic fractionation during laser ablation cannot be overcome. In the present study, the UV laser (or femtosecond laser), was chosen for laser ablation sampling of carbonate minerals. The quartz membrane (Pallflex) was used to collect the carbonate aerosol transported by the Helium gas during ablation. The quartz membrane with carbonate aerosol (~20μg) was then transferred into the CF-IRMS for oxygen and carbon isotope measurement after decomposition with phosphoric acid. With this method, standard deviations of repeat analysis of one bulk homogeneous carbonate sample can reach to 0.3‰ for both $\delta^{18}O$ and $\delta^{13}C$.