



Ice mill: First CO₂-Measurements with a new Extraction Method

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To detect CO₂ changes in quaternary climate in the order of 10-20 ppmv, a reconstruction precision better than 2 ppmv is necessary. Two extraction systems for CO₂ measurements are currently used in Bern: a needle cracker and a sublimation system. The needle cracker shows excellent performance for bubble ice. During the extraction of air from deep ice containing clathrate hydrates, a substantial fractionation could occur due to coarse ice chips after crushing. The sublimation system ensures 100 % of extraction efficiency and works for both pure bubble ice and pure clathrate ice. A drawback of the system is that the whole procedure takes too long to be used for routine measurements.

A new dry extraction device for CO₂ measurements on ice cores, based on the principle of a “coffee mill”, has been developed. The ice is completely milled into powder grains of about 0.25 mm in diameter within a few seconds. This enables an extraction efficiency of the enclosed air of more than 95 % for bubble-ice and of about 90 % for pure clathrate-ice, respectively. The high extraction efficiency allows us to reduce the time of waiting after crushing the ice, which is necessary to get an equilibrium in CO₂ partial pressure of the extracted air, from the hitherto used 5 minutes to just 1 minute. The shorter waiting time, as well as careful design to avoid exposure of the inner surfaces of the device to atmospheric air during cleaning and sample loading, minimize the contamination due to adsorption and subsequent desorption of atmospheric air CO₂, which have been observed by the cracker system. The CO₂ measurements on pure clathrate ice of EPICA Dome Concordia show the same concentrations as those

measured with the cracker did within the analytical uncertainty of the measurements.