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# Development of ice sublimation device for analyses of methane isotopes in ice with high impurities

## Content

Common methods to liberate the air bubbles trapped in ice cores include melting (wet extraction) and mechanical destruction (dry extraction) of ice under vacuum. Wet extraction is commonly used for CH4 analyses; however, a recent study (Lee et al., 2020) showed that the presence of liquid water can introduce extraneous (non-paleoatmospheric) CH4 from the reaction between the meltwater and impurities. Measurements of CH4 using dry extraction methods had previously been done (e.g., Ferretti et al., 2005); however, a laboratory intercomparison study showed that dry extraction system generally have higher blanks (Sowers et al., 1997) for CH4. It is hypothesized that friction between components (either metal with metal or metal with ice) can be a source of contamination (e.g., Nicewonger et al., 2016; Sowers et al., 1997). A third method to liberate air trapped in ice core bubbles is sublimation under vacuum (e.g., Wilson and Donahue, 1989; Schmitt et al., 2011). The sublimation method guarantees complete gas extraction from both the air bubbles and the ice matrix / clathrates (Bereiter et al., 2015), and should be free of problems associated with wet extraction. Here we present a new sublimation system that aims to sublimate ~250g of ice and extract ~25 mL STP of air for measuring CH4 isotopes in ice with relatively high impurities. We use three high powered (500W each) infrared lamps that emit peak radiation at wavelength of 1500 nm, which coincides with a local maxima in ice absorption spectra (Warren and Brandt, 2008). To ensure even sublimation, the infrared lamps are attached to a custom-made mounting bracket that is rotated around the glass vessel. This system is coupled to a previously built Gas Chromatography Isotope Ratio Mass Spectrometry (GC-IRMS) system (Sperlich et al., 2013) to purify and analyze δ13CH4 isotopes. At the time of writing, the GC-IRMS system is able to achieve 0.06 ‰ precision on standard air injections containing contemporary CH4 mole fraction (1850 nmol/mol). Further testing to characterize the performance of the system using blank ice and test ice of known mole fraction and isotope values is underway.

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