# Radiometric dating of ancient glacial ice using $^{81}Kr$

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Polar ice cores have been used to reconstruct Earth's climate and atmospheric composition as far as 800,000 years back in time. A range of techniques is used for the dating of ice cores, including annual layer counting, ice flow modeling, age marker synchronization and orbital tuning. Radiometric dating tools for old ice are currently not widely used because of several distinct drawbacks. Radiocarbon dating on the $CO_2$ present in air bubbles is complicated by in situ cosmogenic $^{14}C$ production in the ice. Other radiometric methods rely on the incidental inclusion of meteorites, tephra layers or organic impurities, and still have limited precision.

With a half-life of 230 ka, $^{81}Kr$ could potentially be used for radiometric dating of old ice with ages ranging from 50 - 1500 ka. $^{81}Kr$ dating has several advantages: (1) the technique is widely applicable as all polar ice contains air bubbles; (2) the technique does not require a continuous or undisturbed ice stratigraphy; (3) there is no in situ $^{81}Kr$ production, as is the case for $^{14}C$; (4) the dating method gives an absolute age estimate. The main disadvantage is the large sample size (> 100 kg), which has precluded use in ice core studies to the present day.

Old ice can not only be obtained from deep ice cores, but also at ice margins and Antarctic blue ice areas (BIAs) where it is being re-exposed by ablation. For paleoclimate studies this provides an interesting alternative to ice coring, as large volume samples can easily be obtained. During the last few years the ice ablating at the Taylor Glacier BIA has been dated using stratigraphic matching techniques. Here we present an ongoing experiment to use the well-dated stratigraphy of Taylor Glacier to test the feasibility and accuracy of $^{81}Kr$ radiometric dating of old ice for the first time.

Using a large diameter ice drill we obtained four 300 kg Taylor Glacier ice samples, which were dated at 10, 50, 80 and 130 ka. The air was extracted from these samples on site by melting the ice under vacuum, and captured in flasks for shipment back to the laboratory. Currently $^{81}Kr/Kr$ analysis is ongoing for these samples. If successful, the experiment would demonstrate that $^{81}Kr$ radiometric dating is indeed feasible. This could pave the way for reliable $^{81}Kr$ dating of other BIAs, which would significantly enhance the scientific value of BIAs in Antarctica. As sample size requirements continue to decrease, $^{81}Kr$ dating of ice core samples might be a future possibility.