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Measurement of atmospheric $^{14}CH_4$ in Antarctic ice over the agro-industrial period: a status report.

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During the 2005 Austral summer, an ANSTO-lead expedition using a thermal ice drill collected a large (20 cm) diameter ice core from near the summit of Law Dome, East Antarctica. The drill reached a depth of 260 m where the ice dated from $\sim$ 1620 AD and the air, contained as bubbles in the ice, from $\sim$ 1680 AD.

This marked completion of the first stage of an ambitious collaborative project to learn more about the sources of the important greenhouse gas methane [CH_4] over the agro-industrial period (from $\sim$1700 AD on). Whilst it is well known that methane has increased from 700 ppb to 1,700 ppb over this time as a result of human activities, the development of the different methane sources is poorly understood. Knowledge of how $^{12}CH_4$, $^{13}CH_4$ and $^{14}CH_4$, as well as CH_3D, have changed in time permits validation of postulated methane source scenarios. We are attempting to make well time-resolved measurements of ^{14}C of CH_4 over this period. With just 100 mL of air obtainable from each 1 kg of ice, combined with the low concentration of methane in the air, special techniques are required to undertake such demanding ^{14}C measurements, even when employing the sensitive technique of accelerator mass spectrometry [AMS].

Core chronology is being established from a combination of techniques. Seasonal ice layers are identified by measurements of $\Delta^{18}O$ of ice, glacio-chemicals and major ions. CO_2 and CH_4 mixing ratios and $\delta^{13}CH_4$ will also be measured along the core. Diffusion of atmospheric gases through the firn and bubble-trapping at the firn-ice transition will be numerically modelled, with the tritium and $^{14}CO_2$ "bomb-pulses" used to constrain model parameters.

Each air sample will be derived from $\sim$100 kg of ice, melted in 25 kg blocks in a

specially-constructed stainless steel melting tank. The air will be stored in glass flasks until the CH_4 is separated and converted to CO_2, stored in glass break-seals. The CO_2 will then be converted to graphite for ionisation in the AMS ion source. Approximately 5 μg of carbon will be derived from each 100 kg of ice, too little for the capability of most radiocarbon AMS labs. As part of this project, a laser-heated reaction vessel, optimised for extremely small samples, has been developed to produce the graphite. Additionally, improvements have been made to the ANTARES accelerator to further improve its small-sample capability. A summary of our progress towards these goals will be presented.