Canada's first in situ ^{14}C extraction line is ready for action

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Applications of in situ ^{14}C produced in minerals or ice on Earth are providing a new frontier in exposure dating and landscape erosion rate studies. In particular, the isotope can avoid problems facing longer-lived, lower production rate isotopes. The Dalhousie ^{14}C Extraction Line Laboratory (DCELL), the first in situ ^{14}C extraction line in Canada, was finished in January 2017 and the first background and blank tests have been completed. Up to 8 g of quartz is melted using $LiBO_2$ flux in an alumina boat to extract in situ ^{14}C. After removal of atmospheric/organic CO_2 from the boat, flux, and quartz at low temperature (500°C), ultrapure O_2 is bled over the melting quartz aliquot at 1050°C to capture the in situ ^{14}C as $^{14}CO_2$. The CO_2 is then purified using temperature-specific pentane-slush traps and a high temperature Ag-Cu wool-mesh oxidation to remove SO_x, NO_x, and other condensable gases. The purified CO_2 is analysed for $^{14}C/^{12}C$ on the MICADAS gas-source accelerator at ETH Zurich, eliminating the need to graphitize the CO_2.

The first blank measurement of 1.96 $x10^5$ atoms was obtained using operating procedures developed to minimize flux mass and volatility while still achieving complete ^{14}C extraction. The blank result is comparable to other similarly designed extraction. The inter-laboratory comparison sample, CRONUS-A, was calculated to be $6.88x10^5$ atoms/g which is also within the concentration range presented by other ^{14}C labs. In the upcoming year the DCELL will be used to estimate erosion rates over the past 35 ka on alluvial fans used as strain markers in Panamint Valley, California, by measuring ^{14}C saturation concentrations in amalgamated sediment samples from just below the soil mixing zone. Those erosion rates are used to constrain cosmogenic ^{10}Be and ^{36}Cl depth profiles to improve the precision of the exposure age and slip rates. Furthermore, in situ ^{14}C measured in quartz sand in till will be used, in concert with ^{10}Be, to improve our knowledge of the erosional dynamics of ice sheets in the Canadian Arctic where mineral exploration is complicated by their polythermal basal thermal regime. Also in the queue are glacial erratics from cold-based glacier regions on Baffin Island. Besides these experiments, we have already begun a process to improve the extraction system in order to reduce the blank by an order of magnitude by eliminating the need for flux and alumina sample boats (the primary source of blanks in most labs).

Atlantic Geology, 2018, Volume 54
Atlantic Geoscience Society Abstracts – 44th Colloquium & Annual General Meeting 2018
doi: 10.4138/atlgeol.2018.003