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Development of a cosmogenic 14C extraction line at Dalhousie University

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Applications of cosmogenic ^{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 C-14 Extraction Line Laboratory (DCELL), the first cosmogenic ^{14}C extraction line in Canada, was completed in January 2017 and is undergoing background and blank tests. Up to 8 g of quartz is melted using $LiBO_2$ flux in an alumina boat to extract cosmogenic ^{14}C. After removal of meteoric CO_2 from the boat, flux, and quartz at low temperature (500˚C), ultrapure O_2 is flowed over the melting quartz aliquot at 1050˚C to capture the in situ ^{14}C as $^{14}CO_2$. The $^{14}CO_2$ is then purified using temperature-specific Liquid Nitrogen-slush traps to remove SO_x, NO_x, and other condensable gases, and a high temperature Ag-Cu mesh oxidation. The purified CO_2 has been analysed for $^{14}C/^{12}C$ on the MICADAS gas-source accelerator at ETH Zurich, eliminating a 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 extraction lines that use $LiBO_2$ flux in alumina boats. The inter-laboratory comparison sample, CRONUS-A, was calculated to be 5.22x10^5 atoms/g which is within the concentration range presented by other ^{14}C labs. In the upcoming year the DCELL will be used to determine 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 samples from just below the soil mixing zone. Those erosion rates are used to constrain ^{10}Be and ^{36}Cl depth profiles in order 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 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.