PRIME Lab Radiocarbon Measurements. D.J. Hillegonds, K.A. Mueller, X. Ma, M.E. Lipschutz; Purdue University, West Lafayette, IN 47907.

The Purdue Rare Isotope Measurement Laboratory (PRIME Lab) is one of three NSF national facilities for accelerator mass spectrometry (AMS), and is the only one capable of determining six cosmogenic radionuclides: ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, and ^{129}I. This abstract describes the current status of the radiocarbon analysis program at PRIME Lab.

Methods

The optimal AMS target material for radiocarbon measurements is graphite, which gives the best negative ion current [1]. After appropriate pretreatment, wood and charcoal samples are vacuum sealed in a quartz combustion tube containing CuO and a small piece of silver foil [2]. The sample carbon is oxidized to CO_2 by heating at 900°C for 3 hours. The combustion tube is then placed in a tube breaker attached to the graphitization line (see Fig. 1). After the line is evacuated (<10 mtorr), the combustion tube is broken and sample CO_2 is collected in trap #2 using liquid nitrogen (T_b= -196°C). The sample CO_2 is then purified, quantified, frozen into a graphitization tube, and reduced to graphite [3,4].

The graphitized sample is loaded into a copper sample holder and placed inside the ion source through a vacuum lock, where a cesium ion beam (0.5 mA current) sputters carbon from the sample surface. The negative ions produced are extracted and pass through an injector magnet, which selects the desired carbon isotope. After pre-acceleration to 86 keV, the ion beam is brought up to 30 MeV using a tandem Van de Graaff accelerator, with a terminal voltage of 6 MV. At the terminal, a gas stripper removes electrons from the anions, forming highly charged cations of various charge states. The analyzing magnet and terminal voltage are optimized for C^{4+} ions, which subsequently pass into a gas ionization detector. The stable isotope ion currents are measured in a Faraday cup at the high energy side of the accelerator, and used to determine the radioactive-to-stable (R/S) isotope ratio.

Results/Discussion

At the time of writing this abstract, we are in the beginning stages of running blanks and standards, as well as conditioning and testing the graphitization line. Dates obtained for pre-processed graphite samples of wood, charcoal, shell, and organic sediment are close to stated values, with nearly equivalent or better precision (0.5 to 2%) than the values reported.

The procedures of wood, charcoal, and shell processing are being tested, while meteorite, bone, and biomedical samples constitute future sample types [5,6,7,8,9,10].

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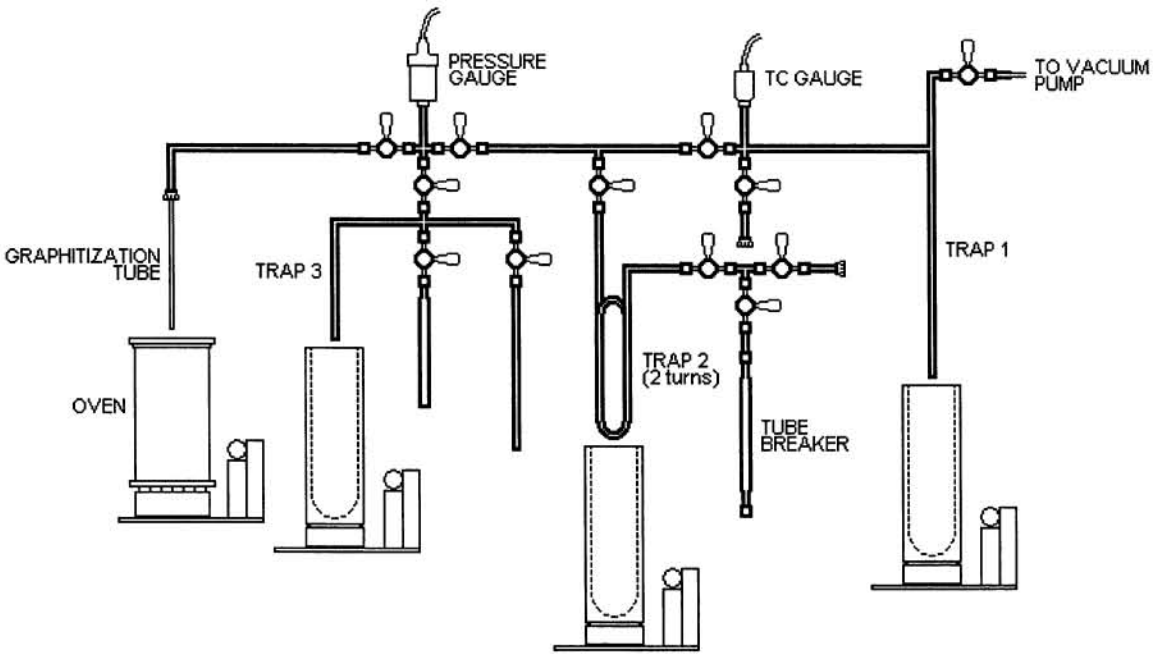

Figure 1: Schematic of the graphitization line at PRIME Lab.

References

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