Experimental developments in low level ^{14}C research

JEFFREY S. PIGATI University of Arizona Desert Laboratory, 1675 W. Anklam Rd., Tucson AZ 85745
JAY QUADE Department of Geosciences, University of Arizona, Tucson AZ 85721
NATHANIEL A. LIFTON Department of Geosciences, University of Arizona, Tucson AZ 85721
A.J. TIMOTHY JULL Arizona-NSF AMS Facility, University of Arizona, Tucson AZ 85721

The challenges posed by ^{14}C dating of very old (35-55 ka) samples and *in situ* cosmogenic ^{14}C dating are similar: (1) complete removal of secondary or "contaminant" carbon from the sample matrix, and (2) complete isolation and recovery of sample carbon during extraction and graphitization. Failure to remove (or the introduction of) even very small amounts of secondary carbon can be fatal for either application. For example, a 100,000-year-old sample that contains 1% modern contamination would yield a "finite" ^{14}C age of ~37,000 years. Similarly, introduction of 1 cc of air during processing of a quartz sample exposed for 1,000 years at sea level and high geomagnetic latitude would yield an exposure age that was ~65% too high. Because of the sensitivity of these applications to contamination, rigorous chemical pretreatment techniques and specialized extraction systems are required.

Over the past decade, our research group at the University of Arizona has designed and constructed extraction systems and developed chemical pretreatment protocols that allow us to isolate *in situ* ^{14}C from quartz. We can now routinely achieve a 2σ precision of ±5% for quartz samples containing as little as ~100,000 ^{14}C atoms g^{-1}. While quartz can be found in most places on Earth, basaltic terrains are an exception. To fill this gap, we conducted numerous chemical pretreatment experiments and step-heated extractions aimed at isolating and extracting *in situ* ^{14}C from olivine. Our results suggest that step-heated extractions alone may be sufficient to isolate *in situ* ^{14}C from olivine.

More recently, we designed and built an extraction system at the University of Arizona Desert Laboratory that is dedicated to measuring very old ^{14}C ages (35-55 ka) in charcoal. In conjunction with a new pretreatment protocol, the acid-base-oxidation stepped-combustion (or ABOX-SC) method developed by Michael Bird and co-workers at Australia National University, the upper limit of reliable ^{14}C measurements for charcoal appears to have been pushed back to ~55 ka – an improvement of 10-15 ka over the current limit. We are currently working to verify and perhaps even improve upon Bird et al.'s results using our new extraction system.