Radiocarbon analysis with accelerator mass spectrometry: recent developments and applications

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The mass spectrometric analysis of radiocarbon (^{14}C) and other long-lived radioisotopes is challenged by very low abundances (ambient $^{14}C/^{12}C$ ratios are $<10^{-12}$) and interferences from stable isobars or molecular fragments of the same mass. Accelerator mass spectrometry (AMS) is a powerful tool for radiocarbon measurement due to high ion currents, the complete suppression of the stable isobar ^{14}N and the efficient breakup of molecular ions such as $^{13}CH^+$ in a collision cell within the accelerator (the so-called stripper). However, any kind of structural information of organic compounds is lost. Recent improvements of the stripping process and the gas-filled particle detectors paved the way for AMS systems with substantially smaller accelerators and, thus, for smaller and more robust devices.

At the University of Bern, the AMS system MICADAS (MIni CArbon DAting System) was installed in 2013. It is equipped with a 200 kV tandem accelerator and requires a floor space of (only) 2.5 × 3 m^2. The hybrid ion source allows the analysis of both, graphite and gas targets. Whereas graphite is often used for routine dating applications of samples containing >0.1 mg carbon, gaseous CO_2 is introduced into the ion source for smaller samples down to 1 µg carbon. Furthermore, it opens up the possibility of hyphenated systems employing CO_2-producing analytical instruments, such as an elemental analyzer, temperature-ramped combustion devices or even chromatography coupled with oxidation. This presentation will summarize these technical developments and give examples of applications from atmospheric sciences, archeological dating and pharmacokinetics.