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Method developments for accelerator mass spectrometry at CologneAMS, dating of sediments with ^{53}Mn and trace organic compounds with sub-μg $^{14}CO_2$ samples

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It has turned out, that accelerator mass spectrometry (AMS) has a great potential for various geological applications. The precision and sensitivity is directly linked to technical developments. Therefore CologneAMS, the center for accelerator mass spectrometry of the University of Cologne, does extensive work on method developments to improve the precision and to develop isotopic ratio measurements for new applications. We present two important technical developments (1) dating of sediments with ^{53}Mn and (2) trace organic compounds with sub-μg $^{14}CO_2$ samples.

(1) The age determination of discontinuously deposited sediments in arid environments can be difficult or impossible as a result of the absence of age-indicating fossils. A novel approach is the measurement of the cosmogenic nuclide ^{53}Mn in deposited micrometeorites.

The measurement of the medium mass isotope ^{53}Mn is difficult because of the interfering isobar ^{53}Cr. The new AMS system at the Cologne 10 MV FN tandem accelerator is designed especially for the measurement of medium mass isotopes, e.g. ^{53}Mn. It provides the opportunity to use several detector systems in different combinations: degrader foils with an electrostatic analyzer, a 4m time-of-flight system, a 135° gas filled magnet, different gas ionization detectors and a projectile x-ray detector.

We will present the first (^{53}Mn/^{55}Mn) isotopic ratios measured at a 10 MV tandem accelerator in the range of 10^{-9} to 10^{-10}, actual limited by background events. Transmission tests show an overall efficiency of 0.0033%, including sputter efficiency, charge state yield, transmissions and software gates. Isotopic ratios of 3.3×10^{-11} can be measured with 10% precision, with a detection limit of 5.0×10^{-11}.

(2) For the measurement of extremely low organic carbon contents of bulk sediments, with 0.01% carbon, technical developments are required to trace organic compounds with 10-50 μg of $^{14}CO_2$ samples. It turned out, that the measurement of $^{14}CO_2$ micro-samples with the gas-ion source of the Cologne 6 MV AMS system in combination with a gas-handling system is an alternative to the development of a micro-scale graphitization. Modern 1μg CO_2 samples, (^{14}C/^{12}C)=1.18×10^{-12}, can be measured with this system with a precision of 2.8%. The overall efficiency is 4-6% and the reproducibility of standard samples is 0.9% with a blank level of 3-6$\times10^{-15}$.