RECENT DEVELOPMENTS AND TRENDS IN ACCELERATOR MASS SPECTROMETRY

L. Keith Fifield and A. Wallner

Department of Nuclear Physics, Research School of Physics and Engineering, The Australian National University, Canberra, ACT 2601.

There are now more than a hundred accelerator mass spectrometry (AMS) facilities around the world, and the number continues to increase rapidly, with at least five systems presently under construction and more on order. Much of this growth is being driven by systems based on small accelerators operating at ≤1 million volts. The lower cost of these smaller systems is bringing AMS within the reach of many more institutions worldwide. Although most of these are dedicated to measurement of ^{14}C, recent technical developments are enabling the measurement of other isotopes of interest to the earth and environmental science communities such as ^{10}Be, ^{26}Al and actinides at accelerating voltages as low as 300 kV. Indeed, for the actinides, principally isotopes of plutonium and ^{236}U, there are spectacular gains in efficiency relative to larger systems, as first demonstrated at ETH Zurich, and illustrated in the Australian context by the new 1 MV accelerator, VEGA, at ANSTO.

In parallel with the proliferation of small systems, there has also been a steady flow of new systems operating in the 5-6 MV range, especially in Europe but also in Australia and Asia, including the new 6 MV accelerator, SIRIUS at ANSTO. The driver for these larger systems has been the need for ^{36}Cl analyses for hydrology and earth science research, but they also offer considerable advantages in terms of efficiency and sensitivity for other important AMS isotopes such as ^{10}Be and ^{41}Ca.

Very large accelerators, such as the 15 million volt 14UD accelerator at ANU, still have a very important role to play, however. At the higher energies available from such accelerators, isobar separation (e.g. ^{36}Cl from ^{36}S or ^{60}Fe from ^{60}Ni), using techniques derived from nuclear physics research, is more effective than at lower energies. As a result, they are extremely versatile, and the ongoing development of new isotopes depends on these large machines. The techniques employed for isobar separation include gas-filled magnets, multi-electrode gas-ionisation detectors and time-of-flight systems. Exquisite sensitivity can be achieved, with $^{36}Cl/^{35}Cl$ and $^{60}Fe/^{56}Fe$ ratios below 10^{-16} possible. Recent high-profile research enabled by this sensitivity was the detection of 'live' ^{60}Fe in deep-sea sediments and crusts indicating multiple nearby supernovae in our galaxy during the last 10 million years.