ACCELERATOR MASS SPECTROMETRY: AN ANALYTICAL TOOL WITH APPLICATIONS FOR A SUSTAINABLE SOCIETY

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Accelerator Mass Spectrometry (AMS) adds the techniques of charged particle acceleration to the basic principles of Isotope Ratio Mass Spectrometry (IRMS) to provide extremely low detection capability (below 1 femtogram) of rare isotopes in in samples of natural materials as small as 1 mg. Depending on the element selected and the configuration of the equipment, sensitivities can reach one part in 10^{15}. The advantages of this small sample size and high sensitivity include the economic benefit of collecting, shipping and preparing much smaller samples, and also the ability to analyse specific chemical compounds within the sample, so that the pathway taken by that compound through complex systems can be more precisely traced or, in the case of radioactive isotopes, more precise chronological information can be provided.

There are currently approximately 160 AMS systems in operation throughout the world, ranging in acceleration voltage from 200 kV to 15 MV, a number which has doubled in the past 10 years. While many which operate at the lowest of these voltages are specifically designed for one element (typically carbon isotopes), there are a number of multi-element machines coming online which operate at 300 kV. Many of these systems can be equipped with integrated sample preparation equipment, such as elemental analyzers, carbonate analysis systems or even IRMS systems for abundant stable isotope analyses of the same sample.

In the over 40 years of the availability or AMS analyses, many applications in Earth, environmental, planetary, biomedical and cultural sciences have been developed. Of particular interest to sustainability are the contributions made to climate change research using ^{14}C and more recently ^{26}Al, ^{36}Cl and ^{10}Be, to provide details about previous climate change events and to monitor the specific events associated with current changes, such as permafrost thawing, sources of atmospheric methane, or carbon cycling in the oceans. For the energy sector, atmospheric measurements of ^{14}C are used to assess the efficacy of bio-remediation programs for fossil fuel spills and the actinides and fission fragments are analysed to monitor the production, use and disposal of nuclear fuel. Cultural applications include collaborations with indigenous communities to provide chronologies for events chronicled in oral histories, some of which include their adaptation to earlier environmental changes.

This presentation will provide a basic overview of AMS technology and follow with examples of some of the applications outlined above.