

ACCELERATOR MASS SPECTROMETRY TECHNIQUES FOR CULTURAL HERITAGE STUDIES

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ANSTO operates four tandem particle accelerators in the Centre for Accelerator Science (CAS) at its Lucas Heights campus. All these machines are used for accelerator mass spectrometry (AMS) and together deliver a suite of radioisotope dating capabilities (including radiocarbon and cosmogenic in-situ) that cover ages from 100's years old to millions years old. Three are used for ion beam analysis (IBA), as described elsewhere. Since its establishment, CAS has strived to develop and refine AMS radiocarbon measurements, improving the precision and reliability and reducing the required sample size by a factor of 1000 from a few milligrams (mg) of carbon to just a few micrograms (μg). This 'micro-sample' capability has allowed the application of AMS radiocarbon studies to an ever-widening range of objects and artefacts. To illustrate this, a few of the interesting archaeological and cultural studies undertaken on our 10-million volt Australian National Tandem for Applied Research (ANTARES) accelerator are presented. These include dating of such unique objects as the Venafrò chessmen, discovered in 1932 in Venafrò, a Roman necropolis in Southern Italy, and the 'Corona Ferrea' (Iron Crown) of Monza (Italy). CAS AMS was heavily involved in establishing reliable dating for the objects from the Egyptian collection from the Nicholson museum in Australia, and for the mediaeval Torah scroll from the rare book collection of Sydney University.

The sophistication of the technique allowing sample sizes in the microgram range, and so the dating of individual chemical constituents of the item, enabled a whole new group of objects to be studied, many of which were not considered suitable previously. This CAS capacity was utilised in several Rock Art studies from Africa to Central Europe, and indeed closer to home for establishing chronology for Rock Art styles in Australian Kimberley and Arnhem Land regions and their Pleistocene antiquity. The 'micro-radiocarbon' capability allowed determining the age of the oldest dated Australian rock motif – a naturalistic depiction of kangaroo – to between 17,500 and 17,100 years ago. Some work has also been undertaken on dating wear and use residues on lithic objects, where the amount of carbon-containing material is very limited.

The AMS facility at CAS is capable of measuring other rare isotopes of intermediate half-life besides carbon, and some of these find application in nuclear heritage studies. As an example, we present measurements of cosmogenic in-situ ^{10}Be and ^{26}Al were used to investigate the evolution of the rock shelters in the Kimberley, where the most rock art in the region is found. Exposure dating of collapsed overhang blocks provided minimum and maximum age limits for the art on the fallen blocks and on freshly exposed surfaces. These results are important not only for establishing the time frame of the motifs, but also for assessments of art preservation and survival over time.

Primary author: Dr LEVCHENKO, Vladimir (ANSTO, Australia)

Co-author: Dr SMITH, Andrew (ANSTO)

Presenter: Dr LEVCHENKO, Vladimir (ANSTO, Australia)

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