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Quality assurance and ^{36}Cl program at SUERC: Implications to landscape evolution research

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In situ-produced cosmogenic nuclei, made by cosmic ray induced nuclear reactions cumulatively on exposed surfaces, are natural chronometers and valuable tools for environmental and geological research. Cosmogenic ^{36}Cl ($t_{1/2}$=3e5 yr) is dominantly produced in spallation reactions on Ca and K, and via neutron capture on ^{35}Cl, and hence is applicable to a range of lithologies for studying events within the last 1 Myr or so. The different ^{36}Cl production mechanisms result in versatility but also challenging data interpretation when unravelling the measured ^{36}Cl concentrations.

The main difficulty in utilising ^{36}Cl for environmental and geological research arises from the stable isobar ^{36}S. However, if high enough ion energies are available, these two isotopes can be separated based upon their different rate of energy loss in matter. This has typically required large (10-15 MV) legacy nuclear physics particle accelerators but recently it has been shown that sufficient separation can be achieved with much lower ion energies than before ($\sim$30 MeV); the detector resolution being improved by using uniform thin ($\sim$30 nm) Silicon rich Nitride membranes as a detector window to minimise energy losses and peak broadening.

As a consequence, measurements can now be done with 5 MV, or even smaller, modern accelerator mass spectrometers utilising gas stripping to produce the highest possible quality beams. Accordingly a new class of commercial purpose-build 5-6 MV ^{36}Cl-capable spectrometers is being deployed around the globe with additional measurement capacity greater than that of the installed base. This should increase accessibility and promote wider and more varied ^{36}Cl use. However, laborious sample preparation chemistry and production rate uncertainties remain difficulties.

An example ^{36}Cl programme utilising the 5 MV accelerator mass spectrometer at SUERC will be presented. Our internal quality assurance program shows that no external uncertainty beyond 3% counting statistics is observed and Purdue PRIMELab Z93-0005 (nominally 1.20e-12 ^{36}Cl/Cl) AMS primary normalization standard is long-term consistent with K. Nishiizumi-provided secondary standard (nominally 5.0e-13 ^{36}Cl/Cl) used for monitoring. In addition to analytical quality of the analysis, monitored with the fore mentioned standards, we present results from an internal chemical standard, used to monitor sample preparation, as well as example data from a recent study of carbonate bedrock exhumation via active faulting.