Cosmogenic radionuclides as signatures of past Solar storm events

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This collaborative project examines the relationship between the 'Carrington Event' (CE), the largest solar storm of modern times [1], and two recently discovered cosmic radiation events of greater magnitude, the 'Miyake Events' (ME) [2, 3]. The intention is to construct cosmogenic isotope (^{14}C, ^{10}Be and ^{36}Cl) profiles across the CE, so they can be compared with similar data that have already been obtained for the ME [4]. We will use ice cores from Law Dome, East Antarctica, collected under Australian Antarctic Science awards, for the ^{10}Be and ^{36}Cl analyses. The large diameter DSS0506 ice core will permit high-resolution measurements at ANSTO of ^{10}Be and ^{36}Cl across the CE. Furthermore, we also intend to measure ^{10}Be and ^{36}Cl in the main DSS ice core across the ME. These measurements will complement existing data as both isotopes will be measured in the same ice core for each event for the first time and at high temporal resolution. New tree rings spanning the CE and ME, sourced from the Oxford Dendrochronology Laboratory, have been measured for ^{14}C at the University of Groningen at mostly annual resolution. The ultimate goal of this study is to determine whether or not all three events are manifestations of the same phenomena. A secondary goal is to provide a check on the independent DSS-main ice core chronology.

The CE of 1859 is known from geomagnetic data and contemporary records of the aurorae, which were observed as far south as the tropics [1]. The event predated ground-based neutron detectors and routine cosmogenic isotope measurement, so the intensity of the incident particle radiation is still a matter of conjecture. Indeed, this question has been thrown into sharp focus recently by new discoveries in palaeoastronomy. Analyses of natural archives (tree-rings and ice-cores) have revealed that production of the cosmogenic isotopes ^{14}C, ^{10}Be and ^{36}Cl spiked dramatically in the years 774-775 AD and 993-994 AD [2, 3, 4]. Such anomalies could only have been generated by sudden bursts of cosmic radiation. Several sources were initially proposed for the radiation, however, the consensus now is that they were driven by solar activity.

Here we discuss progress with the measurement of the cosmogenic radioisotopes and consider how the relative production rates of the cosmogenic radioisotopes may be used to substantiate a solar cause for the historical radiation events and to infer the spectral hardness of the initiating solar protons.

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