Depth profile of ^{10}Be in the West Antarctic Ice Sheet Divide ice core

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Introduction:

Concentrations of cosmogenic ^{10}Be and ^{36}Cl in polar ice cores serve as both a proxy of solar activity and geomagnetic field strength [1-3] and as a tool to help dating ice cores by matching changes in ^{10}Be production rates with other ice core ^{10}Be records and with the ^{14}C tree-ring record [4-5]. Although production is primarily determined by the strength of the solar magnetic field and the Earth's magnetic field, ^{10}Be deposition is also determined by atmospheric mixing, local weather phenomena and snow accumulation rates. Accordingly, multiple ice core records of varying locations and accumulation rates are necessary to build a representative ^{10}Be archive. We are presently engaged in a study to obtain continuous ^{10}Be and ^{36}Cl depth profiles in the West Antarctic Ice Sheet (WAIS) Divide ice core, a high snow accumulation site (20 cm weq yr^{-1}) analogous to the GISP2 core from Greenland [6]. Here we present an annual resolution record of ^{10}Be in the WAIS Divide core spanning the last 420 years, as well as a low resolution record of ^{10}Be and ^{36}Cl in the top 577 m of the core, representing the last 2400 years.

Experimental Procedures:

We used two types of samples from the WDC06A core. For the low resolution record, we collected "waste" water from the outside layer of 3cm x 3cm ice cores that were analyzed for major and trace ions with the continuous ice core melter at the Desert Research Institute (DRI) in Reno. Typical waste samples are 1-2 kg and represent 2-4 m of ice, equivalent to an average temporal resolution of 12 years, using the preliminary age-depth scale based on annual layer counting [7]. After collecting the meltwater we took a small aliquot for chemical analysis and added nitric acid and a carrier solution containing Be, Al and Cl. For the annual layer samples, we used two small strips of ice from the outside of the WDC06A core. Typical samples weigh between 100-300 g (depending on annual snow accumulation). After melting the ice samples, we added 0.15 mg of Be carrier and filtered the samples through a 30 μm Millipore filter. Be, Al and Cl were separated using ion exchange chromatography techniques [6]. The ^{10}Be and ^{36}Cl concentrations were measured by accelerator mass spectrometry (AMS) at PRIME lab, Purdue University. Typical 1σ uncertainties in the ^{10}Be results are 2-5% for the waste samples and 2-8% for the annual ice samples.

Results:

The ^{10}Be concentrations in the waste samples range from 8 to 19 x 10^3 at/g, while those in the annual ice layers range from 8 to 40 x 10^3 at/g. The ^{10}Be concentrations in ice samples of the top 114 m are systematically higher than those in the corresponding waste samples, indicating that 30 ± 10 % of the ^{10}Be is lost during the waste sample collection. Despite the lower ^{10}Be concentrations in the waste samples, the relative ^{10}Be depth profile in WDC06A shows good agreement with that of the GISP2 ice core, showing elevated ^{10}Be concentrations during periods of low solar activity, known as Oort, Wolf, Spörer, Maunder and Dalton minima.

The ^{10}Be record for the WAIS Divide core will be compared to ^{10}Be records in ice cores from Greenland [6,8] and ice cores from Antarctica, including Siple Dome [9] and Dome Fuji [10], as well as the ^{14}C tree ring record. The annual ^{10}Be record for the last 420 year will be compared with the annual sunspot record, neutron monitor records and with total solar irradiance to investigate the relationship between cosmogenic ^{10}Be, solar activity and solar forcing of climate.

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References.

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