

MEASUREMENTS OF ^{36}Cl IN POLAR ICE

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ABSTRACT

We are measuring ^{36}Cl in the upper part of the 1966 Camp Century deep core, using the tandem-accelerator mass-spectrometry facility at the University of Rochester. There are two primary motivations for measuring ^{36}Cl in ice. The first is to look for correlations between ^{36}Cl concentrations and changes in solar activity. Previous studies of ^{10}Be and ^{14}C (Stuiver and Quay 1980, Raisbeck and others 1981, Beer and others 1983) have demonstrated that the production of these radio-isotopes increases during periods of low solar activity. When the sun is active, the magnetic field induced by the solar wind deflects galactic cosmic rays from the inner solar system and thereby lowers the production of radio-isotopes. Our study of ^{36}Cl in ice dating back to A.D. 1550, from Camp Century, Greenland, shows that there was an increase in ^{36}Cl production during the Maunder Minimum (1650-1715). However, climatic variations introduce fluctuations of a factor of 2 or more over short periods and the Maunder Minimum peak is only readily apparent when the data are smoothed mathematically.

The second motivation for measuring ^{36}Cl in ice is to test the possibility that the ratio of ^{36}Cl to ^{10}Be will provide a means for dating ice over 50 000 years old (Nishiizumi and others 1983). The dependence on both solar activity and climatic fluctuations mentioned above precludes dating with a single radio-isotope. If, however, the production rates of ^{36}Cl and ^{10}Be are each proportional to the cosmic-ray flux and are transported identically to the ice sheet, these fluctuations would cancel and the ratio of ^{36}Cl to ^{10}Be would provide a radiometric means of dating very old ice. The half-lives for ^{36}Cl (3.0×10^5 years) and ^{10}Be (1.6×10^6 years), combine to give a "half-life" for the $^{36}\text{Cl}/^{10}\text{Be}$ ratio of 3.7×10^5 years.

Unfortunately, preliminary results from Camp Century, Greenland, show that it will almost certainly not be possible to use the $^{10}\text{Be}/^{36}\text{Cl}$ ratio for dating. ^{10}Be and ^{36}Cl have

been measured in more than 20 samples; the $^{10}\text{Be}/^{36}\text{Cl}$ ratio varied, without any obvious pattern, from below 5 to over 15. Additional evidence comes from Antarctica. We found that the $^{10}\text{Be}/^{36}\text{Cl}$ ratio changed significantly within a short depth interval within a single block of ice and that the calculated age of ice based on $^{10}\text{Be}/^{36}\text{Cl}$ differed from the age of an embedded meteorite, ALHA82102 (personal communication from K. Nishiizumi).

A variation in the $^{10}\text{Be}/^{36}\text{Cl}$ ratio may be caused by climatic effects: for example, changes in air circulation between the stratosphere and the troposphere in the polar region, in combination with chemical processes that affect aerosol chlorine and beryllium differently. Also, the $^{10}\text{Be}/^{36}\text{Cl}$ ratio is smaller than expected, indicating that there may be additional sources of ^{36}Cl . If there is a source of ^{36}Cl that varies independently from the galactic cosmic-ray flux, this would result in variations in the isotope ratio. Discovery of the cause of the variations may result in a new tool for understanding paleoclimate.

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