Absolute dating of the last 7000 years of the Vostok ice core using ^{10}Be

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Ice cores have proven to be very valuable sources of palaeoclimatic information. Complete exploitation of this information requires reliable dating of the ice. In regions of relatively high ice accumulation, seasonal variations in several parameters (stable isotopes, conductivity, trace impurities, dust etc) have been used to obtain continuous year by year dating, at least in the upper portion of the core where these signals are still identifiable. Over large areas of the Antarctic plateau however, the accumulation rates are too low to record such yearly signals. In these cases chronologies have largely relied on modelling and/or stratigraphic correlation with parameters assumed to be globally synchronous (for example volcanic horizons or methane trapped in bubbles in the ice). As has been previously pointed out, variation in cosmogenic ^{10}Be can also been used for stratigraphic correlation (Raisbeck and Yiou, 1989). The cosmogenic production rate of ^{10}Be depends on (i) the primary cosmic ray intensity, (ii) the strength of the geomagnetic field, (iii) the level of solar magnetic activity. In the Antarctic, and over the time scales of interest here, this last parameter is likely the most important. However, independent of their origin, variations of ^{10}Be production offer a globally synchronous and potentially very high resolution signal for stratigraphic correlation. In addition, if these variations can be correlated with those in an absolutely dated reservoir, they offer a way of obtaining absolute dating for the ice. We discuss such an application in the present paper.

Using the Gif sur Yvette accelerator mass spectrometry facility, a nearly continuous profile of ^{10}Be concentrations with 0.5 m resolution has been measured in a 178 m ice core at Vostok station. On the basis of the EGT time scale (Jouzel *et al*, 1993), this depth corresponds to ~ 6700 years BP. This profile shows significant secular variations which are believed to be mainly the result of variable solar modulation. Assuming that the cosmogenic ^{14}C production rate was proportionnal to the ^{10}Be concentrations on the EGT time scale, the ^{10}Be data have been used as input data in a carbon cycle model to simulate an atmospheric ^{14}C record (Bard *et al*, 1997). This ^{14}C record was then compared to the observed ^{14}C profile in dendrochronologically dated tree rings. Differences between the simulated and observed ^{14}C curves were then used to modify the assumed ice ages, and the process repeated iteratively to obtain a maximum in the correlation coefficient between the simulated and observed ^{14}C curves. The resulting age for the Vostok core is older than the originally assumed EGT time scale by a gradually increasing amount which eventually reaches ~400 years at 7000 BP .

References

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