Geophysical Research Abstracts
Vol. 12, EGU2010-3894-1, 2010
EGU General Assembly 2010

Insights into the European glacial palaeoclimate from phosphate δ^{18}O in mammoth tooth enamel

Laura Arppe (1) and Juha Karhu (2)

(1) University of Helsinki, Department of Geology, University of Helsinki, Finland (laura.arppe@helsinki.fi, +358 9 19150826), (2) University of Helsinki, Department of Geology, University of Helsinki, Finland (juha.karhu@helsinki.fi, +358 9 19150834)

Quantitative palaeoclimatical and -ecological records on the European continent from the time period prior to the LGM in MIS 3 and 2 (ca. 59 – 21 ka) are scarce and fragmentary, and particularly poor in the core areas of the Scandinavian Ice Sheet (SIS) in Northern Europe. In this area, the palaeoenvironmental record contained in mammal skeletal remains can prove invaluable.

This study makes use of the numerous finds of woolly mammoth (*Mammuthus primigenius*), which was common across most of Europe during the latest – the Weichselian – glacial age. Mammoth molars discovered from Estonia, Latvia, Lithuania, Poland and Denmark were analysed for the oxygen isotope composition of enamel phosphate to explore spatial patterns and temporal variations of glacial $\delta^{18}O_{ppt}$ (oxygen isotope value of precipitation) in northern Europe prior to and after the LGM during MIS 3 and 2. The molars (n=28) have all been radiocarbon dated (AMS), and have calendar dates from 49 to 11 ka.

In order to extend the geographical coverage of the δ^{18}O data, the new results were combined with compiled oxygen isotope data from prior investigations of mammoth enamel phosphate and palaeogroundwaters. The enamel-derived long-term mean glacial $\delta^{18}O_{ppt}$ values agree remarkably well with local glacial palaeogroundwater oxygen isotope levels in several European locations. The combined dataset facilitates a first approximation of the geographic distribution of $\delta^{18}O_{ppt}$ values in glacial precipitation over much of Europe.

The long-term mean values for the oxygen isotope composition of precipitation in Europe at 52-24 ka were $\sim$1-4‰ lower than those for the present-day precipitation, with the largest changes recorded in the currently marine influenced southern Sweden and the Baltic region (Arppe and Karhu, 2010). The reconstructed geographic pattern of $\delta^{18}O_{ppt}$ in glacial precipitation reflects the progressive isotopic depletion of air masses moving northeast, consistent with a westerly source of moisture for the entire region, and a circulation pattern similar to that of the present day. The application of regionally varied δ/T-slopes, estimated from palaeogroundwater data and modern spatial correlations, yields reasonable estimates of glacial surface temperatures in Europe and imply 2-9˚C lower long-term mean annual surface temperatures during the glacial period.

The isotopic composition of carbon in enamel was also analysed and, as expected, it indicates a pure C3 diet for the European mammoths (Ukkonen et al., in prep.). A faint geographical gradient in the δ^{13}C values of enamel is discernible, with more negative values in the northeast.

References

Arppe, L, Karhu, J.A., 2010. Oxygen isotope values of precipitation and the thermal climate in Europe during the middle to late Weichselian ice age. Quaternary Science Reviews, revision submitted.

Ukkonen, P., Aaris-Sørensen, K., Arppe, L., Clark, P.U., Daugnora, L., Lister, A., Lõugas, L., Seppä, H.A., Stuart, A.J., Wojtal, P., Zupins, I. Northern Europe in the Middle to Late Weichselian: palaeoenvironment of the woolly mammoth (*Mammuthus primigenius* Blum.) In preparation.