EVIDENCE FOR A PLIO-PLEISTOCENE STRENGTHENING OF THE ASIAN MONSOON AND ITS IMPORTANCE TO THE UNDERSTANDING OF MAMMALIAN EVOLUTION IN NORTHWEST CHINA

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Introduction

The uplift of the Tibetan Plateau during the Cenozoic Era is considered to be the driving force in the development of the Asian monsoons, and the timing of this development is crucial to the understanding of mammalian evolution in China. The physical barriers created by the plateau are also important to the understanding of the migrations of mammals. Linxia Basin, located on the northeastern margin of the Tibetan Plateau, has produced an abundance of well-preserved horse fossils. Bulk and serial stable carbon and oxygen isotopic analyses of tooth enamel carbonate from 15 individuals within the genera *Equus* and *Hipparion*, ranging in age from 11.5 to 0.05 Ma, have allowed reconstruction of the ancient climates and ecologies of those individuals.

Results and Discussion

Bulk $\delta^{13}C$ values of tooth enamel carbonate from all individuals indicate a primary diet of C3 grasses, with the exception of one individual from 1.2 Ma that incorporated a considerable amount of C4 grasses in its diet. Bulk O-isotope analyses show significant shifts to more negative values after 11.5, 7.5, and 6 Ma, and to more positive values after 14, 9.5, 7, and 2.5 Ma, indicating a shift to either drier or warmer conditions, or both after 14, 9.5, 7, and 2.5 Ma (Figure 1).

The serial $\delta^{13}C$ and $\delta^{18}O$ values of tooth enamel from 0.05 to 11.5 million-year-old horses suggest that all horses, with the exception of the 1.2 Ma specimen, had a steady C3 diet and that the positive $\delta^{18}O$ shifts indicated in the bulk analyses are accompanied by greater variation in $\delta^{18}O$ in the serial analyses for any given individual, suggesting increased seasonality (Figure 2).

Conclusions

Bulk C-isotope analyses indicate that the pure C3 diets of horses in the Linxia Basin changed to a mixed C3/C4 diet after 2.5 Ma, indicating a Plio-Pleistocene strengthening of the summer monsoon. Bulk O-isotope analyses show significant shifts to more positive values after 14, 9.5, 7, and 2.5 Ma, suggesting a shift to either drier and/or warmer conditions. Serial $\delta^{18}O$ data suggest these positive $\delta^{18}O$ shifts are accompanied by increased seasonality.

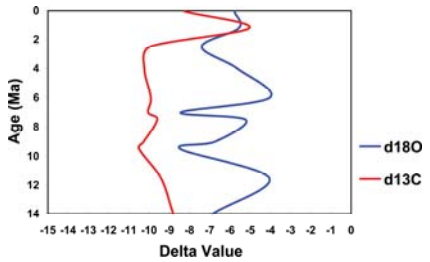

Figure 1. Average bulk δ values (in per mil, VPDB) of tooth enamel versus age of fossil horses from Linxia Basin.

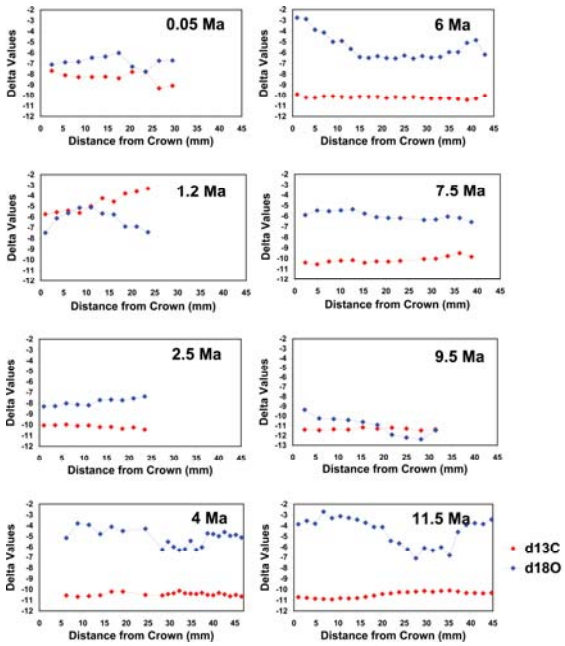

Figure 2. Serial analyses of fossil horse tooth enamel. Graphs show δ values (in per mil, VPDB) versus distance from tooth crown in individuals of various ages from Linxia Basin. One individual is represented for each age.