Stable isotopic composition of pedogenic carbonates in Chinese loess sequences: Information for paleo-summer monsoon strength

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As an important paleoclimatic archive, the loess-paleosol sequence on the Chinese Loess Plateau has been widely studied during the past decades, which serves as a complete record of East Asian monsoon evolution and embodies the regional response to global changes. The bulk samples from the Luochuan, Xifeng and Huanxian loess sections over the last 130ka were separated into three grain size fractions, i.e. >45μm, 45~2μm and <2μm. It is shown that $\delta^{13}C$ and $\delta^{18}O$ of carbonates in different fractions differ greatly. There is a striking contrast between micrographs of the carbonates in the >45μm fraction and that of in the <2μm fraction. Compared with $\delta^{13}C$ and $\delta^{18}O$ of authigenic carbonate in fossil snail shells and rhizoconcretion, it can be concluded that the carbonate in the >45μm fraction are mainly detrital, while the carbonate in the <2μm fraction is mainly pedogenic, precipitated during pedogensis.

$\delta^{13}C$ and $\delta^{18}O$ of pedogenic carbonate (the <2μm fraction) in the Huanxian, Xifeng and Luochuan sections reflect a spatial evolution of paleo-summer monsoon strength, i.e. decreasing from southeast to northwest. The fact that the C_4 plant contents calculated from $\delta^{13}C$ at the three regions has increased since the last 130ka denotes that the precipitation in these areas decreases gradually. According to paleo-temperatures and the C_4 contents calculated from $\delta^{13}C$ and $\delta^{18}O$ in the pedogenic carbonate and rhizoconcretion, the long-term variation of paleoclimate and paleoenvironment in Luochuan area over the last 2.5 Ma can be divided into two stages around the paleosol layer S_5. Before S_5 formation, the summer monsoon strength generally increased with alternating rise and decline of winter monsoon intensity, and the temperature and precipitation increased gradually. After S_5 formation, intensified winter monsoon causes the decreases of the temperature and precipitation and increase of C_4 plant contents.

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Correction strategies in deuterium analysis using chromium reduction

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Introduction

High precision deuterium isotope analysis (D/H) of water is routinely carried out by using a hot chromium reactor. One crucial point is to observe and correct for the machine drift. Consequently, different strategies for drift correction were proposed (e.g. Nelson and Dettman, 2001; Werner and Brand, 2001). In this study different correction approaches were tested for their influence on quality control and their usability in day to day analysis. Measurements were carried out on a H/Device coupled to a Delta S mass spectrometer.

Results and Discussion

Different reactor types (standard packing and alternative mix proposed by Nelson and Dettman, 2001 for longer reactor life) were tested for differences in drift behavior. Provided that all other parameters are identical, the results show a strict linear drift for the standard packing and a polynomial drift for the alternative packing of the reactor.

Miscellaneous correction functions, including polynomial, linear point-to-point and Rayleigh fractionation were evaluated. Results show that a simple second order polynomial regression to the drift of the signal from the standard bellow yields the best results. Two quality control standards treated as unknowns were measured in each run. After this correction external reproducibility - defined as standard deviation of the control standards during all runs - was 0.5 ‰ and 0.7 ‰, respectively.

Reactors with different packing were reheated several times and the results of different runs were compared. It turned out that reheating of reactors has no influence on the quality of the data, a fact that is generally worried about. The influence of an additional memory correction applied to the raw data prior to drift correction was evaluated, too.

Conclusions

The results show that an external precision of 0.5 ‰ is reachable in routine analysis if this standardized polynomial drift correction is applied.

References

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