A record of middle to late Miocene CO_2 decrease from the Tianshui Basin, Gansu, China

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A decline in the concentration of atmospheric CO_2 is hypothesized to have driven cooling, Antarctic ice sheet growth and the global expansion of C_4 vegetation during the late Miocne. However, existing records conflict on the direction of CO_2 change from the middle-to-late Miocene. We report a paleosol carbonate-based atmospheric CO_2 record showing pronounced CO_2 decrease from 17-8 Ma, supporting the interpretation that late Miocene paleoenvironmental change was triggered, or at least accommodated, by CO_2 decrease.

Carbonate nodules were sampled from the paleosols preserved in the fluvio-lacustrine depositional sequences of the Tianshui Basin, Gansu, China, which have a deposit age of 17-6 Ma based on magnetostratigraphy. These paleosols are characterized by 0.5-2m thick Bk horizons bearing carbonate nodules and/or rhizoliths and, near the bottom of the section, well-preserved roots up to 0.5 cm in diameter. We measured the $\delta^{13}C$ values of carbonate nodules collected > 20 cm below the top of Bk horizons. We also measured $\delta^{13}C$ values of organic matter occluded in carbonates.

The $\delta^{13}C$ values of paleosol carbonate nodules decrease from -4.0 ± 0.2 ‰ (1σ, n=3) at 16.5-17 Ma to -8‰ at 8 Ma whereas the $\delta^{13}C$ values of occluded organic matter average -25.5 ± 0.5 ‰ (1σ, n= 8) with no trend. Assuming the calcium carbonates formed at 25°C and using contemporaneous $\delta^{13}C$ values of atmospheric CO_2 from [1], calculated values of $R = (\delta^{13}C_s - 1.0044(\delta^{13}C_r) - 4.4)/(\delta^{13}C_a - \delta^{13}C_s)$ [2] decrease by 3 fold from 17 to 8 Ma. Using a distribution of *S(z)* values (soil-respired CO_2 concentrations [2]) determined from modern Aridisols [3,4], our best values suggest atmopsheric CO_2 decreased from 600 to 200 ppmV from 17 to 8 Ma. Consideration of uncertainties on each CO_2 determination results in 88% probability of CO_2 decrease across the interval.

[1] Tipple *et al* (2010) *Paleoceanography* **25**, PA3202. [2] Cerling (1991) *AJS* **291**, 377-400 [3] Moñtanez (2013) *GCA* **101**, 57-75 [4] Breecker (2013) *Geochem Geophys Geosys* **14**, 3210-3220