New constraints on ancient atmospheric oxygen concentrations and the Late Triassic rise of the first North American dinosaurs

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We have developed a new proxy for ancient atmospheric oxygen concentrations based on the composition of soil carbonate-hosted fluid inclusions. Fluid inclusions form in equilibrium with the soil pore space gas during inclusion closure. Based on modern soil gas measurements, we show that the atmospheric gases liberated from soil carbonate-hosted inclusions closely reflect soil gas concentrations and contain all the major atmospheric species. The concentration of O_2 in soil pore space gas is controlled by respiration and diffusion-mediated exchange with the atmosphere, and we show that profiles of fluid inclusion compositions can be used along with production-diffusion modeling to reconstruct atmospheric pO_2. An inversion of the diffusion model can be solved iteratively to predict atmospheric O_2 from the gases hosted in modern soil carbonates and reproduces modern atmospheric pO_2. The model is then applied to Late Triassic paleosols from cores taken through two contemporaneous sedimentary sequences that formed >1000 km apart across the Pangean supercontinent: the Colorado Plateau and Newark Basin Coring Projects (CPCP and NBCP). Combined results from the Colorado Plateau and Newark Basin show a secular increase in pO_2 that corresponds to a decrease in pCO_2, coinciding with the appearance of the very first North American dinosaur, *Chindesaurus*.