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Calibrating timescales and measuring pCO_2 to test the role of LIP volcanism in the Miocene Climate Optimum

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Large igneous province emplacement in the Columbia River Basalt Group (CRBG) has been suggested to cause elevated global temperatures and pCO_2 of the Miocene Climate Optimum (MCO). However, assessing the connection between volcanism and warming depends on developing accurate and precise chronologies for both events. While we have developed a new age model for CRBG volcanism based on zircon geochronology (Kasbohm & Schoene, 2018), only a small number of MCO proxy records have been age-calibrated through astronomical tuning, and there remains a paucity of radiometric ages targeting this event. Existing boron isotope pCO_2 proxy records from the MCO were obtained from sites with age models based on biostratigraphy, hindering correlation to known intervals of CRBG volcanism.

Here, we present the first high-precision U-Pb zircon ages targeting the duration of the MCO from volcanic ashes in ODP Site 1000 (Nicaragua Rise), which we use as an absolute age calibration for a new high-resolution bulk carbonate $\delta^{13}C$ and $\delta^{18}O$ record from this site that shows isotopic features observed in other Miocene deep-sea sediment cores. Our new ages from Site 1000 pinpoint the interval of CRBG volcanism in the core, coincident with the interval of greatest sustained warmth in the MCO found at Site 1000 and other records, yet the onset of warming begins hundreds of thousands of years prior to the onset of volcanism. We also present a new high-resolution (~15 ka) boron isotope record from IODP Site U1490 (Western Pacific Warm Pool), which has an astronomically tuned age model concordant with our radiometric ages. This new record, targeting the onset of the MCO through the end of the main phase CRBG volcanism (17.1-16 Ma), shows well-resolved and relatively stable pH values across the MCO. We find small changes in CO_2 that are coincident with CRBG volcanism but are likely insufficient to be the main driver of MCO warming. We do not observe changes in CO_2 prior to volcanism consistent with hypotheses of cryptic degassing. While our work reinforces the correlation in ages of the CRBG and MCO, these new records suggest a limited causal role for the CRBG in the MCO.