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Fidelity of high-resolution paleoclimate signals from the Middle Miocene Clarkia lacustrine deposit: From megafossils to molecular isotope

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High quality paleoclimate records based upon sedimentary archives require precise determination of geochronology, well-constrained sedimentation rates, and cross examination of multiple proxies for the fidelity of climate signals. A better understanding of the source, preservation potential, and diagenetic impact of various sedimentary materials—fossils, biomolecules, or isotopic signals—is critical to improve paleoenvironmental reconstruction. These advantageous requirements can be met in the Miocene Clarkia lacustrine deposit in northern Idaho, where extraordinary fossil and organic preservation associated to the Columbia River Basalt (CRB) Group volcanism during the peak warming of the Miocene Climate Optimum (MCO).

Created by the CRB flows damming the proto-St. Maries River, the Middle Miocene (15.78 ± 0.039 Ma, U-Pb zircon ages of interbedded volcanic ashes) Clarkia Lake yields annually-resolved deposition formed during a millennium timeframe. Traditional taphonomic studies indicated that organic-rich Clarkia sediments host an exceptionally preserved mega-fossil flora of more than 150 species retaining high percentage of organelles and other cellular details. Submillimeter-scale organic geochemical investigations established *in situ* preservation of a suite of biomolecules, and compound specific carbon and hydrogen isotope analysis suggested primary geochemical fingerprints preserved in both fossils and sediments. Supplemented by micro-fossils and equally well-preserved insect and fish fossils, the Clarkia biota reflects a Miocene ecosystem of both terrestrial and aquatic environments under warm temperate climate conditions.

Interdisciplinary research at Clarkia during the past five decades revealed molecular level diagenetic process controlled by the change of paleolimnological conditions. CRB-related, geologically-instantaneous lake shallowing event played a decisive role in changing lake redox conditions and switched the Clarkia Fossil *Lagerstätten* from a conservation deposit to a concentration deposit, pointing toward the critical role of different microbial communities in mediating key fossilization processes in a clay mineral-rich environment. The precisely-dated and high-resolution Clarkia lacustrine sequence yields decadal scale CO_2 and temperature records reconstructed within a 1,000 years' time window during the MCO associated with major carbon-cycle perturbations that can be compared with near future human societal time scale under doubling of pre-industrial CO_2 levels.