

## Lake Ice Rafted Debris in Deep Time Lacustrine Archives: A New Proxy for Ancient Continental Freezing

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Lake ice rafted debris (L-IRD) is commonly used in Neogene paleoclimatology studies as an indicator of seasonal and perennial ice cover. However, this proxy is rarely used in studies on lithified lake sediments. Here, we present the methods used to identify the first empirical evidence of Arctic continental freezing in the early Mesozoic (1). This toolkit involves chemical disaggregation of sediment samples and serial digestions to remove cements, authigenic minerals, organic material, and microfossils. Next, we use laser diffraction granulometry to generate high resolution grain size distributions. Computed tomography (CT) scanning and thin sectioning is used to assess the spatial distribution and orientation of individual clasts. Finally, we compare ancient samples to a dataset of grain size distributions and CT scans of lake sediment from modern seasonally frozen and perennially frozen lakes. These datasets provide specific criteria for identifying L-IRD in ancient sediments. Since L-IRD survives low-grade metamorphism, unlike many chemical proxies, this method is one of the only ways to track continental freezing through geologic time from the Archean to today.

1 Olsen et al (2022) Science Advances 8(26):eabo6342

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