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Late Triassic Arctic ice in lacustrine strata of the Junggar Basin NW China

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Despite having perhaps the highest levels of atmospheric CO_2 in the Phanerozoic, new evidence of abundant lake-ice-rafted debris in the Late Triassic and earliest Jurassic lacustrine strata of the Huangshanjie, Haojiagou, and Badaowan formations of the Junggar Basin of Northwestern China (paleolatitude $\sim 71^\circ$ N) indicate that freezing winter temperatures typified the forested Arctic during this this time. Here we focus on one particular lacustrine interval in the middle Haojiagou Formation. This formation is comprised of a cyclical gray and black clastic sequence comprised of coals, black shales, and gray sandstones with facies apparently paced by orbital cyclicity including obliquity (1). A black mudstone in the middle of Bed 24 is very laterally persistent and does not change appreciably in thickness or facies over a distance of at least 2 km along strike. Fossils include relatively small amounts of plant debris and dissarticulated to associated fish and tetrapod fragments. The absence of microlaminations or articulated fish suggest that the lake in which this unit was deposited was not oxygen-stratified at this site, although it is far from the lake depocenter. Floating in the well-bedded but not laminated fine silty claystone are sand to gravel-sized lithic clasts. They are generally not clustered and we interpret them as lake ice-rafted debris (L-IRD) similar to sea-ice rafted debris. The mudstone was disaggregated in hydrogen peroxide and analysed for grain-size using both Sedigraph (with sieving) and Coulter Counter techniques with similar results with the fine fraction peaking between 1 and 10 microns and with the >63 micron fraction peaking between 250 and 1000 microns. Thus far, the largest clast seen is about 1200 microns in its longest dimension. The clasts tend to be sub-rounded with relatively low sphericity. We discount algal rafting because of the lack of clustering of grains into pods and think root rafting is unlikely because of the relative rarity of large woody material, with the most parsimonious hypothesis being lake-ice rafted where ice freezing to the shoreline in fall or winter drifts out into the open lake during thaw, dropping its debris. Not all lacustrine mudstones in the Late Triassic-Early Jurassic sequence have L-IRD and we have not found any in the younger Early Jurassic Sangonghe Formation thus far. Early Mesozoic quantified L-IRD should serve as a valuable paleoclimatic proxy and we envision it being useful to tease out the interplay between pCO_2 and orbital pacing in modulating high-latitude climate during this otherwise hot-house time.

1. Sha J, et al. (2015) PNAS, 112(12):3624-3629.