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Extreme hydroclimate events between early-1100s and mid-1200s recorded in the Deep Springs Lake, California: constraint from carbonate minerals

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Southwestern North America witnessed extreme hydroclimate events during the Medieval era and sequential periods based on evidence from tree rings and lake shorelines. However, details about these events remain vague due to the lack of historical records of North America and limited paleoclimate archives. Located in the California desert, the Deep Springs Lake (DSL) is a spring fed alkaline playa continuously precipitating dolomite under current circumstances. When it turns much drier than nowadays climate, Ca-bearing magnesite can precipitate; when the lake water is diluted during a wet period, calcium carbonates (calcite and aragonite) precipitate together with dolomite.

In this study, we collected a series of samples from DSL and analyzed the samples with quantitative X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). We quantified proportions of carbonate minerals and detrital silicate minerals for each sample and found their significant variations with the depth. We confirmed all carbonate minerals precipitated from the lake water in a primary way based on previous studies of water chemistry and our observations. Notably, there is a detrital-free magnesite and dolomite layer (~4 mm thickness) at depth of ~70 cm. The detrital-free magnesite-rich layer formed during extreme dryness period. The deposition age of the magnesite-rich layer was estimated based on deposition rate of the dolomite-bearing sediments and mineralogy changes of the core samples. The magnesite-rich layer is consistent with the anomaly low water level of nearby Owens Lake (65 km south) between early-1100s and mid-1100s, which is about the time of the late Northern Song Dynasty in Chinese history. Above this layer, a large amount of detrital minerals occurred together with aragonite and calcite, which coincided with a wetter climate during Medieval Pluvial. A new dryness/humidity index is proposed for the studied site, based on weighted contents of magnesite, dolomite, calcite and aragonite, which can also be applied to other lakes in arid areas. This study provides more details for Medieval megadroughts and Medieval Pluvial in North America.