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Relative timing of mountain glacial maxima and pluvial lake highstands in the Great Basin, western United States

Benjamin Laabs¹ and Jeffrey Munroe²

¹North Dakota State University, Geosciences, United States of America (benjamin.laabs@ndsu.edu)

²Department of Geology, Middlebury College, Middlebury, Vermont, United States of America (jmunroe@middlebury.edu)

During the last Pleistocene glaciation, dozens of mountain ranges in the Great Basin of the western United States were glaciated and numerous valleys were occupied by pluvial lakes. This unique setting provides an opportunity to reconstruct regional-scale climate change during the last glacial-interglacial transition based on a well-documented record of lacustrine deposits and moraines. Chronologies of water-level changes in pluvial lakes throughout the Great Basin have been developed through decades of effort chiefly involving radiocarbon dating of fossil material recovered from paleoshorelines and sediment cores. Glacial chronologies have been developed more recently through cosmogenic nuclide exposure dating of glacial features in mountains of the northern Great Basin. Here, we resolve the relative timing of mountain glacial maxima and pluvial lake highstands based on an analysis of these chronologies. The moraine record displays evidence of two intervals of near-maximum glacier length, one represented by terminal moraines with cosmogenic nuclide exposure ages 22-19 ka, and another represented by downvalley recessional moraines with exposure ages 18-16 ka. The earlier maximum corresponds to the latter part of the global Last Glacial Maximum, during which lake highstands occurred in the southern Great Basin, whereas many lakes in the northern Great Basin were below their highstand levels. The climate in the northern Great Basin during this interval was apparently cold enough to drive glaciers to their maximum extents but too dry for the expansion of lakes, in contrast to the southern Great Basin where conditions were wetter. The latter glacial maximum was synchronous with lake highstands across much of the Great Basin and to the early part of Heinrich Stadial 1, which featured persistent cooling and shifting precipitation patterns in western North America. Most lake highstands occurred at this time, although some lakes in the extreme northwestern Great Basin reached highstands somewhat later. Widespread lake highstands during the interval 18-16 ka combined with near-maximum glacier lengths suggests a cool and wet climate favoring both glacial and lacustrine maxima, despite rising atmospheric greenhouse gases and summer insolation. Nearly all downvalley moraines in the Great Basin were abandoned by 16 ka, whereas many lakes persisted until 15 ka or later. This pattern suggests a climatic shift at ca. 16 ka to conditions favoring lakes but not glaciers. By the time of the last lake highstands, glaciers had diminished greatly in length and were generally confined to cirques.