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Extinct lakes of the American desert west

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Erosional Pleistocene shorelines in Surprise Valley, California, USA. Credit: Anne Egger

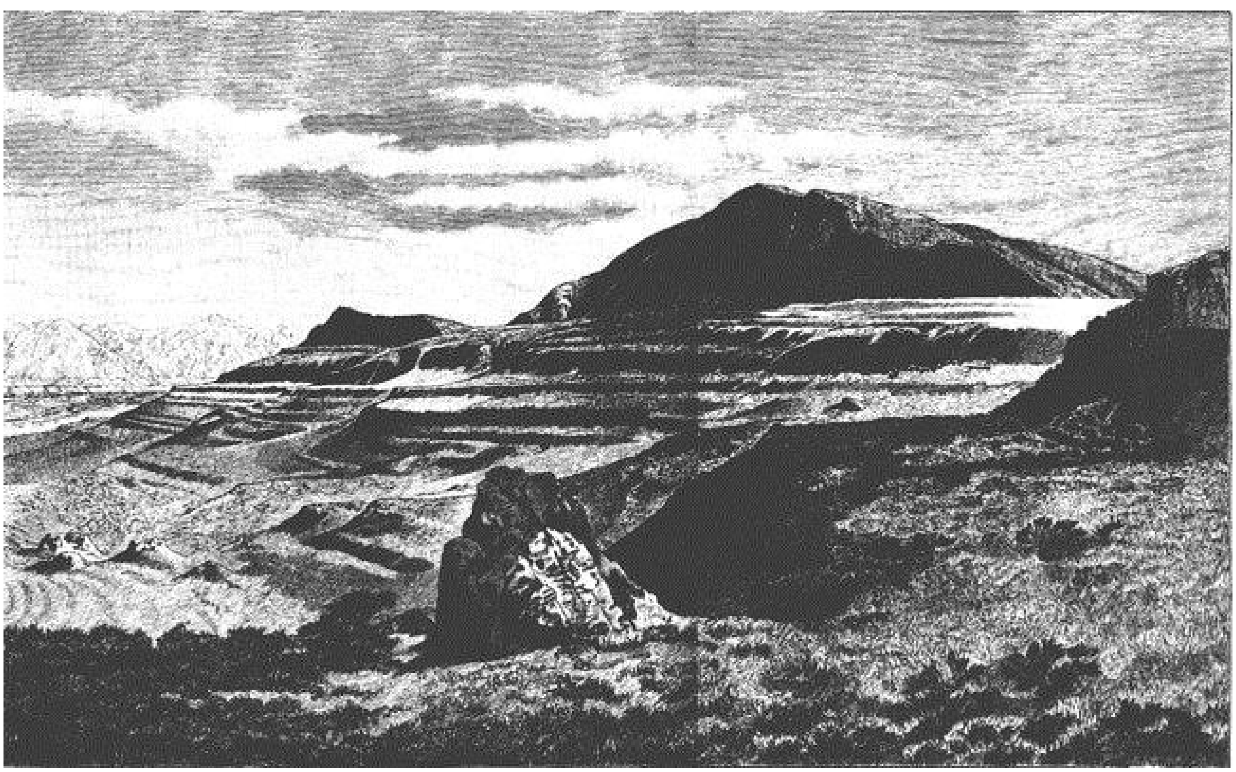
Boulder, Colo., USA: The vestiges of lakes long extinct dot the landscape of the American desert west. These fossilized landforms provide clues of how dynamic climate has been over the past few million years.

Identification of ancient lake shoreline features began with early explorers of the continent. The first detailed studies were conducted by pioneering American geologists such as G.K. Gilbert and I.C. Russell in the late 1800s, who studied Lake Bonneville, now the remnant Great Salt

Lake in Utah, and Lake Lahonton, located in northwestern Nevada.

Through this long history of studying fossil shorelines and lake sediments, we know that these lakes existed during two periods with distinct environmental conditions during the geologically recent past. The first was during ice age maxima, such as the last ice age, 14 to 30 thousand years ago, when global temperatures were 4 to 6 degrees colder and continental ice sheets expanded into the continental United States.

The second time period was about three million years ago during the middle of the Pliocene epoch—a global climate characterized by warmer temperatures and atmospheric CO2 levels roughly equivalent to today's values, which has led many scientists to view the Pliocene as a potential analogue for future climate change.



Shorelines of Lake Bonneville along the Oquirrh Mountains, Utah, USA. (H.H.

Nichols [artist] and G.K. Gilbert, in Gilbert, 1884). Credit: H.H. Nichols [artist] and G.K. Gilbert, in Gilbert, 1884. Public domain.

These observations lead to an important question, says the study's lead author, Daniel Ibarra, "Why are there lake systems under both colder and warmer climates, but not today?" Of particular interest, he says, is the presence of lakes under warmer conditions, which, under a "wet gets wetter, dry gets drier" paradigm, goes against projections of future warming.

To answer this question, Ibarra and colleagues looked at the competing influences of temperature and precipitation, and how they combine to allow for the existence of lakes under these dual climate states.

The authors compiled evidence for, and created models of, lakes during both colder and warmer than modern periods of the Pliocene-Pleistocene (the last 5 million years). During colder glacial periods, they found that increased precipitation and decreased evaporation combined to form large lakes that occupied the inward draining basins in the western United States, particularly in northern Nevada and Utah.

Increased precipitation also drove the formation of lakes, particularly in southern Nevada and southern California during the warmer middle Pliocene, outpacing higher temperatures and evaporation rates during that time. This increase in precipitation during the middle Pliocene and dominantly southwestern distribution of lake deposits is similar to the pattern of precipitation during modern El Niño years, corroborating previous hypotheses for mean "El Niño-like" conditions during the mid-Pliocene.

The team's interdisciplinary approach explains the conditions driving lake systems in mid-latitude regions today and over the geologic past. Further, notes Ibarra, "This work illustrates the importance of understanding how the El Niño Southern Oscillation drives precipitation patterns in arid regions, which is important for future water resources planning for the western United States."

More information: Gilbert G. K., 1884, The topographic features of lake shores. United States Geological Survey, Fifth Annual Report, 69–123.
DE Ibarra, AE Egger, KL Weaver, CR Harris, K Maher, 2014, Rise and fall of late Pleistocene pluvial lakes in response to reduced evaporation and precipitation: Evidence from Lake Surprise, California, Geological Society of America Bulletin, 126 (11-12), 1387-1415.

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