Mono Lake Tufa State Natural Reserve

Mono Lake and Mono Basin

Features/Processes:
Geochemistry of a desert lake, and saline "statues"

Mono Lake is one of the most unusual lakes in the world. Situated against the towering eastern front of the Sierra Nevada, the lake is at the boundary between the Sierra Nevada and Great Basin geomorphic provinces. Based on study of sediments that underlie the lake, geologists believe it is at least 760,000 years old and may be one or two million years old. In 2008, its salinity was about twice that of the ocean. The main causes of this unusually high salinity are the age of the lake (i.e. very long period of evaporation), its lack of an outlet to carry away dissolved salts from the contributing sediments, and the diversion of some of its freshwater sources to supply water demand in southern California, which began in 1941. The lake water contains large amounts of bicarbonate, sodium, chloride, and sulfate. The water is extremely alkaline (pH = 10), which makes it caustic.

What you can see: Mono Lake is an ancient saline lake whose recent history has been significantly affected by man's activities. Within the lake and along its shore are bizarre tufa formations. These have formed by springs reacting with the highly mineralized and concentrated, salty water of Mono Lake. North, east, and south of the lake are volcanic mountains. To the west is the dramatic fault scarp of the Sierra Nevada.

Mono Lake is contained within a large, shallow depression called Mono Basin. The basin probably began to form 3–4 million years ago, mainly by subsidence of the basin floor possibly due to volcanic eruptions and subsequent chamber collapses. As Mono Basin formed, creeks and springs flowed into it to create Lake Russell. Mono Lake is but a small remnant of this ancient lake. Abundant freshwater springs, some of them hot, are still active in the basin. Rising abruptly at the western edge of Mono Basin is the Sierra Nevada. At the foot of the range, a large fault, the Sierra Nevada Frontal Fault, is present, along which the Sierra Nevada has risen and Mono Basin has fallen. The maximum difference in elevation between the crest of the range and the basin floor is about 7,000 feet.

Panum Crater, south of Mono Lake and south of the park boundary, erupted explosively as recently as about 650 years ago. The volcanic mountains on the north and east sides of the basin are much older and more eroded.

Tufa Formations

Two types of bizarre natural features rise from Mono Lake and its shoreline. These are the “tufa towers” and “related sand structures,” which are the geologic highlights of the Natural Reserve, and the basis for protective legislation establishing the State Natural Reserve in 1982. Tufa is a chemical deposit of calcium carbonate, which is the same compound that makes limestone. Tufa is still being deposited at Mono Lake. The basic process of its formation is known through research at Mono Lake and

Why it's important: Mono Lake Tufa State Natural Reserve is one of the rare places in the world that contain such a unique group of geologic features. The tufa formations are notable for their unusual shapes and abundance. Extensively studied by scientists, they have aided our understanding of the climate history of this region. The extremely high salinity and alkalinity of Mono Lake has created a rare ecosystem, supporting a complex food chain of green algae, brine shrimp and alkali flies, and more than 80 species of migratory birds.

elsewhere around the world, but scientists still do not fully understand the details of how tufa forms. For example, although organisms such as algae are found with tufa, their roles in the process of its formation are still uncertain.

Tufa towers rise vertically from the lake and shoreline as chimney-like formations up to 30 feet high; some are estimated to be several hundred years old. The towers were progressively built upwards beneath Mono Lake when freshwater springs carrying dissolved calcium discharged from the lake bottom and chemically reacted with the bicarbonate-bearing lake water to deposit calcium carbonate. Standing individually or in clusters, some towers still have spring water flowing out of their summits, sides, or bases. Because the artificial diversion of the inflows of fresh water caused the lake's level to drop, we are able to see the towers exposed today. As the lake rises eventually to its legally mandated level of 6,392 feet above sea level (it was at 6,383 feet in 2008), some of the presently exposed towers will again be submerged.

On the dry land adjacent to the lake are many sand-tufa structures, which are composed of pumice sand cemented by calcium carbonate. They are masses of tubes and columns suggestive of tree roots or worm burrows, although they did not form by biologic processes. Instead they formed by the movement of calcium-bearing freshwater springs and groundwater through layers of loose pumice sand near the shore of Mono Lake. These layers were saturated with the highly saline lake water that also helped form the tufa towers. As the fresh water encountered the more dense lake water in the sand, the fresh water rose upward. Where it was in contact with the saline water, deposits of calcium carbonate formed to cement the sand grains together. As the lake water receded—starting in 1941—the layers of pumice sand were exposed to erosion by wind. Because the cemented pumice sands were resistant, the loose sands were eroded away and the harder sand-tufa structures remained behind. Some of the structures have flat layers of caliche (a type of calcium carbonate) at their tops, which likely formed at or just below the ground surface shortly after the lake receded. This caliche layer protects the underlying fanciful and delicate tufa sand structures from erosion.

Final Thoughts

Many of the lakes in the Basin and Range are but small remnants of larger predecessors that formed while glaciers covered the northern and southern latitudes of the continents.

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