Prepared in cooperation with the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service

Using Citizen Scientists to Collect Oxygen and Hydrogen Isotope Data in Southern Nevada

What is Citizen Science?

Citizen science programs provide a means for Federal and non-Federal government agencies to make science more engaging, transparent, and accessible by partnering with the public for the purpose of problem solving, data collection, and monitoring. Public volunteers become directly involved in local research, thereby engaging in scientific projects. The public has already been included in existing citizen science programs that cover a broad range of disciplines, such as ecology, hydrology, and tectonics. Citizen science advances research while simultaneously fostering a sense of involvement and interest from the public.

Beginning in 2017, the U.S. Geological Survey (USGS), U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service collaborated with private, non-profit partners to inventory, survey, and rehabilitate springs in Clark County, Nevada. The USGS maintains the National Water Information System (NWIS), a publicly available online database of water-resources data for the Nation, and the agency is interested in using citizen science to add geochemical data from springs in southern Nevada.

From 2021 to 2023, the USGS directly worked with citizen science partners, including the Springs Stewardship Institute and the Friends of Nevada Wilderness, to collect stable isotope and tritium samples from southern Nevada springs. The citizen science volunteers were provided the training and supplies for proper sample collection by USGS staff. As the citizen science partners traveled and hiked to the remote spring sites to complete spring surveys and perform restoration activities, they collected stable isotope and tritium samples for the USGS. Samples were shipped to national USGS laboratories for analysis, and the results were uploaded to the NWIS database (U.S. Geological Survey, 2024).

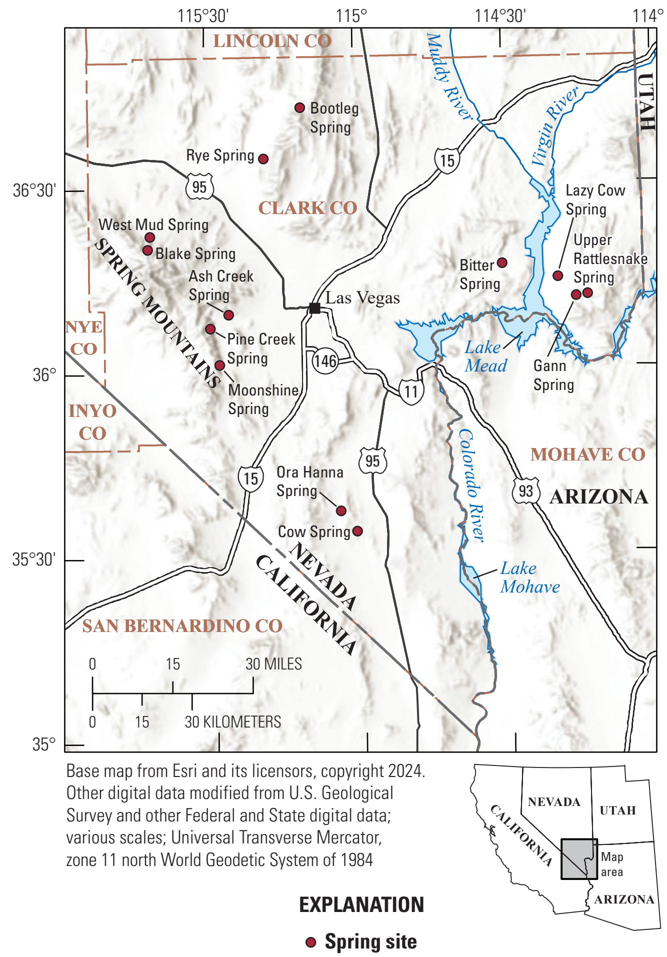

Figure 1. Location of southern Nevada springs visited and sampled by citizen science participants from 2021 to 2023.

How Will Scientists Use the Data?

Springs are fed by groundwater, making them useful natural sites to study the subsurface movement of water (Manga, 2001; fig. 1). Isotopes are variations of the same chemical element; however, the atomic weight changes with different numbers of neutrons (Sulzman, 2007). Stable isotopes do not undergo radioactive decay over time and include isotopes of oxygen (oxygen-18, oxygen-16) and hydrogen (hydrogen-2, hydrogen-1). Differences in the ratios of stable isotopes of oxygen and of hydrogen can be used to help identify groundwater sources (McGuire and McDonnell, 2007). Tritium (hydrogen-3) is an unstable isotope of hydrogen, meaning that it undergoes radioactive decay over time into helium (helium-3). Nuclear weapons testing in the mid-20th century caused a spike in tritium (introduced into the hydrologic cycle) many times greater than the natural production rate (Michel and others, 2018). Using knowledge of atmospheric tritium concentrations over time and its decay rate, the amount of tritium in a sample aids in determining the age and sources of groundwater (Plummer and Friedman, 1999).

What Were the Results of the Project?

The stable isotope ratios and tritium levels of each spring site are shown in table 1. Data are accessible through the NWIS database using the Water Quality Portal (https://www.waterqualitydata.us/). Higher tritium concentrations generally indicate younger water that was recharged by more recent precipitation. Depleted stable isotope ratios (more negative) generally mean the spring water was recharged at a higher elevation or colder climate than less depleted water (fig. 2).

Fact Sheet 2024–3042
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Table 1. Stable isotope ratios and tritium levels of spring sites (U.S. Geological Survey, 2024).

[ID, identification; TU, tritium unit; δ^2H, hydrogen stable isotope ratio; δ^{18}O, oxygen stable isotope ratio]

Site name	Station ID	Tritium (TU)	δ^2H (‰)	δ^{18}O (‰)
Ash Creek Spring	360930115255101	—[1]	−88.4	−11.87
Bitter Spring	361707114304801	0.33	−76.58	−10.34
Blake Spring	362013115415301	2.20	−100.77	−13.75
Bootleg Spring	364300115104901	3.76	−87.79	−12.10
Cow Spring	353404115005501	—[1]	−67	−8.34
Gann Spring	361136114160901	1.79	−78.6	−10.29
Lazy Cow Spring	361445114194301	0.10	−75.58	−9.55
Moonshine Spring	360122115274701	0.31	−92.12	−12.25
Ora Hanna Spring	353724115040501	—[1]	−71.4	−8.94
Pine Creek Spring	360717115293301	—[1]	−79.8	−11.05
Rye Patch	363447115182101	1.61	—[1]	—[1]
Upper Rattlesnake Spring	361151114135101	0.71	−76.81	−10.54
West Mud Spring	362219115412501	—[1]	−100.2	−13.61

[1]Indicates no available isotope data.

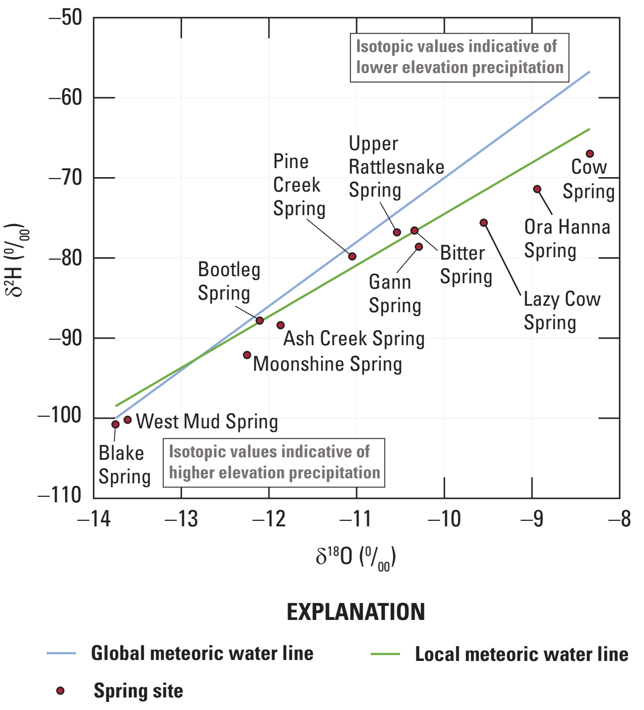

Figure 2. Plot of delta deuterium against delta oxygen-18 in parts per mil (parts per thousand relative to Vienna Standard Mean Ocean Water) of spring sites (red circles; U.S. Geological Survey, 2024), global meteoric water line (blue line [$\delta^2H=8{\cdot}\delta^{18}O+10$]; Craig, 1961), and local meteoric water line (green line [$\delta^2H=6.4{\cdot}\delta^{18}O-10.5$]; Moscati and Scofield, 2011).

How Can I Get Involved in Citizen Science?

The USGS has partnered with the public for a variety of water-resources and ecological projects. Visit the following link to find a project that interests you today! https://www.usgs.gov/youth-and-education-in-science/citizen-science

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By Joshua M. Gonzales, Katherine J. Earp, and Sade K. Cromratie Clemons[1]

[1]Intern through the U.S. Geological Survey Bromery Internship Program.

For more information concerning the research in this report, contact the
Director, Nevada Water Science Center
U.S. Geological Survey
2730 North Deer Run Road
Carson City, NV 89701
https://www.usgs.gov/centers/nevada-water-science-center

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