Data Article

Building Mexican isoscapes: Oxygen and hydrogen isotope data of meteoric water sampled across Mexico

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A B S T R A C T

Oxygen and hydrogen isotope data of meteoric water samples are compiled from several States across Mexico. This dataset includes 287 oxygen and hydrogen (and deuterium excess) isotope data corresponding to meteoric water collected from the surface, groundwater wells, irrigation and observation wells, and water supply boreholes. These data facilitate the development of maps to determine the spatial distribution of water stable isotopes, also known as “isoscapes”, of the Mexican territory. As such, this dataset (and the isoscapes built from it) is useful in geographic mobility studies that aim to evaluate geographic origins and residency of particular human and/or non-human individuals in antiquity and in contemporary times. Further discussion about the data and an example of an isoscope of Mexico using the meteoric water oxygen isotope data are provided in “Residential Patterns of Mexica Human Sacrifices at Mexico-Tenochtitlan and Mexico-

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Tlatelolco: Evidence from Phosphate Oxygen Isotopes” (Moreiras Reynaga et al., 2021). Overall, the dataset is useful in developing interpolated maps of water stable isotopes for relevant archeological, bioarchaeological, forensic, hydrogeological, and ecological research.

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### Specifications Table

| Subject | Hydrology/Hydrogeology |
|---------|-------------------------|
| Specific subject area | Stable isotope tracers in meteoric water |
| Type of data | kmz file |
| How data were acquired | Sample ID’s 1–234 were analyzed using off-axis integrated-cavity output laser spectroscopy (Model DLT-100; Los Gatos Research Inc.). Sample ID’s 247–272 were analyzed using a VG Micromass 602C isotope ratio mass spectrometer. The remaining samples were prepared using conventional preparation methods and analyzed via isotope ratio mass spectrometry (instrument make and model not specified). Excel was used to compile the isotope data. ArcMap was used to develop a map displaying the locations of the water samples collected across Mexico. |
| Data format | Analyzed. Secondary Data. The oxygen isotope analytical data are reported relative to Vienna Standard Mean Ocean Water (VSMOW) in per mil (‰). |
| Parameters for data collection | The oxygen and hydrogen isotope data derive from water samples that were collected by several researchers from 1962 to 2010 across the Mexican landscape. Uncertainty for the oxygen (δ¹⁸O) and hydrogen (δ²H) isotope data are ±0.2‰ and ±2.0‰, respectively. |
| Description of data collection | The oxygen and hydrogen isotope data come from water samples collected from surface water, groundwater wells, irrigation and observation wells, and water supply boreholes across the Mexican territory. |
| Data source location | The water samples were collected at multiple States across Mexico: Baja California (30.8406° N, 115.2838° W); Baja California Sur (26.044° N, 111.6661° W); Campeche (19.8301° N, 90.5349° W); Chiapas (18.7569° N, 93.1292° W); Chihuahua (28.6330° N, 106.0691° W); Coahuila (27.0587° N, 101.7068° W); Colima (19.2452° N, 103.7241° W); Durango (24.5593° N, 104.6588° W); Guanajuato (21.0191° N, 101.2574° W); Guerrero (17.4392° N, 99.55451° W); Hidalgo (20.0911° N, 98.7624° W); Jalisco (20.6595° N, 103.3494° W); Mexico City (19.4326° N, 99.1332° W); Michoacán (19.5665° N, 101.7068° W); Morelos (18.6813° N, 99.1013° W); Nayarit (21.7514° N, 104.8455° W); Nuevo León (25.5922° N, 99.9962° W); Oaxaca (17.0732° N, 96.7266° W); Puebla (19.0414° N, 98.2063° W); Quintana Roo (19.1817° N, 22.5716° W); Sinaloa (25.1721° N, 107.4975° W); San Luis Potosí (22.1565° N, 100.8855° W); Sonora (20.2972° N, 110.3309° W); Tabasco (17.8409° N, 92.6189° W); Tamaulipas (24.2669° N, 98.8363° W); Veracruz (19.1738° N, 96.1342° W); Yucatán (20.7099° N, 89.0943° W); and, Zacatecas (22.7709° N, 102.5832° W). Specific coordinates per water sample are located in: QandHistotopes_Mexico.xlsx. Primary data sources: Cortés and Farvolden 1989; Edmunds et al. 2002; IAEA 1992; Isaa et al. 1984; Jaimez-Palomera et al. 1989; Ortega-Guerrero et al. 1997; Pérez-Quezadas et al. 2015; Portugal et al. 2005; Vázquez-Sánchez et al. 1989; Wassenaar et al. 2009. |
| Data accessibility | Data provided within this article. |
| Related research article | D. K. Moreiras Reynaga, J. Millaire, X. Chávez Balderas, J. A. Román Berrelleza, L. López Luján, F. J. Longstaffe, Residential Patterns of Mexico Human Sacrifices at Mexico-Tenochtitlan and Mexico-Tlatelolco: Evidence from Phosphate Oxygen Isotopes, J. Anthropol. Archaeol. 62 (2021): 101296 |
Value of the Data

- The compiled data provide insights into the stable oxygen and hydrogen isotope ratios of meteoric water across the Mexican territory, which facilitates the development of interpolated maps of Mexico to aid in the assessment of geographic origins and mobility in ecological, archeological, bioarchaeological, and forensic studies.
- Researchers working on hydrology/hydrogeological problems across the Mexican landscape as well as researchers evaluating geographic residencies and mobility patterns of humans and non-humans across Mexico within ecological, archeological, bioarchaeological, and forensic contexts.
- The data can be used to develop interpolated maps or isoscapes using geographic information systems software (e.g., ArcGIS) in ecological, archeological, bioarchaeological, and forensic studies investigating geographic mobility within the Mexican landscape.
- The data also provide useful insights into the hydrological cycle and associated local meteoric water lines, including the relationship between $\delta^{18}$O, $\delta^{2}$H, and deuterium excess within the Mexican territory.
- The data can be used to investigate the relationships between water samples from surface water and groundwater as well as the associated isotope effects such as seasonal, altitude, continental, and rainout effects across the country of Mexico.

1. Data Description

The data compiled include meteoric water stable isotope ratios ($\delta^{18}$O, $\delta^{2}$H) collected and analyzed by several researchers [1,2,3,4,5,6,7,8,9,10] across the Mexican territory between 1962 and 2010. The water samples were collected from surface water, shallow groundwater wells, observation and irrigation wells, and water supply boreholes across Mexico. The water samples, and their corresponding isotope data, include the Mexican States of Baja California, Baja California Sur, Campeche, Chiapas, Chihuahua, Coahuila, Colima, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, Mexico City, Michoacán, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, Quintana Roo, Sinaloa, San Luis Potosí, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán, and Zacatecas. For a discussion on the spatial distribution of the $\delta^{18}$O data across the Mexican landscape and to view an example of an oxygen isotope isoscope of Mexico using these data refer to Moreiras Reynaga et al. [11].

WaterSamples_Mexico.kmz – Google Earth map showing the sampling locations.
OandHisotopes_Mexico.xlsx – table with the 287 meteoric water stable oxygen and hydrogen isotope data compiled. The table includes location, Mexican State, sampling date, latitude, longitude, $\delta^{18}$O and $\delta^{2}$H values, deuterium excess, sample type, and primary sources from where the data were compiled. Note that five $\delta^{18}$O and $\delta^{2}$H values are averages taken from isotope values of multiple water samples collected at the same location. These averaged isotope values are noted as such in the “Sample Type” column.

2. Experimental Design, Materials and Methods

The majority of the samples (ID 1–234) in this dataset were collected and analyzed by Wasse-naar and colleagues [10]. They collected water samples throughout the year 2007 from shallow (<5–20 m in depth) groundwater stations with ~50 km latitudinal spacing across Mexico. Collected water samples were stored unfiltered in tightly sealed plastic containers until they were analyzed in the laboratory. To obtain $\delta^{18}$O and $\delta^{2}$H, samples were analyzed using off-axis integrated-cavity output laser spectroscopy (Model DLT-100; Los Gatos Research Inc.). Samples were normalized based on calibrated internal laboratory standards relative to VSMOW (0 ‰) and
VSLAP (δ²H = −428 ‰; δ¹⁸O = −55.5 ‰), with analytical precision for δ¹⁸O and δ²H ± 0.1 ‰ and ± 0.8 ‰, respectively [10].

For water samples (ID 238–246) from the Mexicali Valley, Portugal and colleagues [8] collected them from observation and irrigation wells during 1997 and are labelled “Group A” in their study. To sample in observation wells a discrete interval sampler was used up to a depth of ~50 m, while samples were extracted from the irrigation wells at no more than 200 m depth. Sample oxygen and hydrogen isotopes were obtained using gas source mass spectrometry, where CO₂ was equilibrated with water to measure oxygen, and H₂ generated from water reduction with Zn for measuring hydrogen [8].

Water samples (ID 247–272) from Mexico City were collected and analyzed by Edmunds and colleagues [2]. Samples were collected from water supply boreholes crossing Mexico City on a west-east transect. Filtered samples (0.45 μm) were stored in low-density polyethylene bottles. The water samples were analyzed at the British Geological Survey using a VG Micromass 602C mass spectrometer to obtain oxygen and hydrogen isotope measurements [2].

Water samples (ID 275–281) from Veracruz reported by Pérez-Quezadas and colleagues [7] were sampled using rain collectors during the rainy season in 2010 along a transect from the Port of Veracruz (0 m asl) up to Cofre de Perote at 4220 m asl. The meteoric water was collected throughout the rainy season period (May–Oct.) and stored in containers that were covered by heat insulating materials along with 250 ml of inert Nujol mineral oil to reduce evaporation. A 60 ml sample was collected from each container at the end of the rainy season and stored in a high-density polyethylene bottle. The water samples were analyzed for stable oxygen and hydrogen isotopes at the Mass Spectrometry Laboratory of the Institute of Geology at the National Autonomous University of Mexico (UNAM). Sample isotope values were normalized relative to VSMOW and SLAP and analytical precision for δ¹⁸O was ± 0.1 ‰ and for δ²H was ± 1.0 ‰ [7].

The water samples (ID 282–286) from Morelos were collected from groundwater wells and analyzed by Jaimez-Palomera and colleagues [5] between 1986 and 1987. The samples were analyzed using the conventional isotope methods in the Mass Spectrometry Laboratory of the Institute of Physics at the National Autonomous University of Mexico (UNAM). Samples were normalized relative to VSMOW and analytical precision was ± 0.2 ‰ for δ¹⁸O and ± 2.0 ‰ for δ²H [5].

The water oxygen and hydrogen isotope averages (ID 235) for samples reported by Issar and colleagues [4] were originally collected from five groundwater wells (3p, 4p, 5p, 6p, and 7p) in the Texcoco Lake region (Sierra Nevada) by Quijano. The water sample (ID 273) collected by Ortega-Guerrero et al. [6] from the middle of the Chalco Plain was sampled from cumulative rain during the month of December of 1989. The sample was filtered (0.45 μm), stored in a plastic container, and low-density silicone oil was added to reduce evaporation. Oxygen and hydrogen isotopes were measured at the Environmental Isotope Laboratory of the University of Waterloo, Canada. The isotope data were normalized relative to VSMOW and analytical precision was better than ± 0.2 ‰ for δ¹⁸O and ± 2.0 ‰ for δ²H [6].

The oxygen and hydrogen isotope averages (ID 274) for rain samples analyzed by Cortés and Farvolden [1] were collected from the Mexican highlands in the Sierra de las Cruces between 1985 and 1986. Rain was collected into containers and low-density Nujol oil was added to avoid evaporation. Samples of 75 ml were extracted and stored unfiltered in a glass, wax-sealed container. Conventional isotope methods were used and samples were analyzed at the University of Waterloo, Canada. Analyzed isotope data were normalized relative to VSMOW and analytical precision was ± 0.2 ‰ for δ¹⁸O and ± 2.0 ‰ for δ²H [1]. The water oxygen and hydrogen isotope average compositions reported by Vázquez-Sánchez and colleagues [9] correspond to water collected from groundwater wells in the Cuautla and Yauatepec Valleys, Morelos. These samples were analyzed and normalized relative to VSMOW and analytical precision was ± 0.2 ‰ for δ¹⁸O and ± 2.0 ‰ for δ²H [9].

The water oxygen and hydrogen average isotope compositions (ID 236–237) of precipitation were collected using meteorological stations in Chihuahua and Veracruz as part of the
IAEA/WMO network, Isotopes in Precipitation, between 1962 and 1987 [3]. The water samples were analyzed in IAEA’s Isotope Hydrology Laboratory.

CRediT Author Statement

Diana K. Moreiras Reynaga: Conceptualization, Investigation, Writing – Original Draft, Writing – Reviewing and Editing; Jean-François Millaire: Conceptualization, Supervision, Visualization, Writing – Reviewing and Editing; Ximena Chávez Balderas: Conceptualization, Writing – Reviewing and Editing; Juan A. Román Berrelleza: Writing – Reviewing and Editing; Leonardo López Luján: Writing – Reviewing and Editing; Fred J. Longstaffe: Conceptualization, Supervision, Writing – Reviewing and Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107084.

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