New stable isotope map of Angola helps archaeologists trace individual life histories across the African Diaspora

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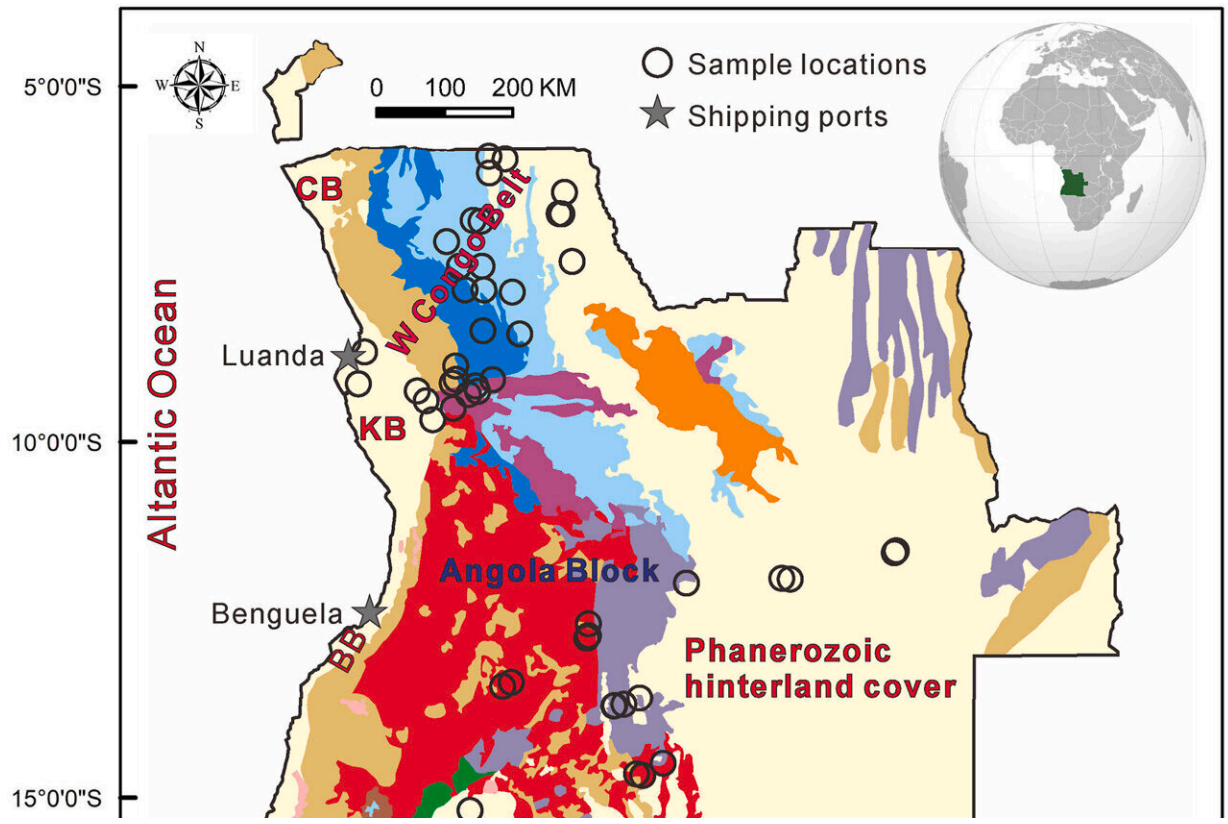


Plant sampling locations in this study and the geological map of Angola modified after Garzanti et al. (2018) and Dinis et al. (2017) (CB: Congo Basin; KB: Cuanza Basin; BB: Benguela Basin; NB: Namibe Basin). Credit: *Journal of Archaeological Science* (2023). DOI: 10.1016/j.jas.2023.105775

Archaeologists at UC Santa Cruz used predictive modeling to map strontium isotope ratios across all of modern-day Angola, a region in Southwest Africa that was once a major hub for the transatlantic slave trade. Researchers compared the resulting map with existing data on strontium isotope ratios from human remains to predict likely regions of origin within Angola for four individuals who had been buried in cemeteries for enslaved people across the Americas.

The team's findings, published in the *Journal of Archaeological Science*, demonstrate how detailed "isoscape" maps could help to fill gaps in historical knowledge about where people were originally captured and trafficked within the African continent. The method also offers a way to uncover personal stories from the unidentified remains of people who were enslaved.

"Using these archaeological methods is basically the only way of giving these individuals back their own life history, which has remained untold in the historical documents," said Associate Professor of Anthropology Vicky Oelze, who led the research alongside postdoctoral researcher Xueye Wang.

Oelze explained that while genetic analysis of human remains can trace a person's ancestry back to a particular region, sophisticated forms of stable isotope analysis powered by machine learning can go further. These methods have the potential to actually estimate specifically where a person was born. And in the context of the African Diaspora, that means archaeologists can differentiate a first-generation enslaved person—who endured the passage from Africa—from other people with similar ancestry whose family had already been enslaved in the Americas for at least a generation.

How it works: Developing a new 'isoscape' for Angola

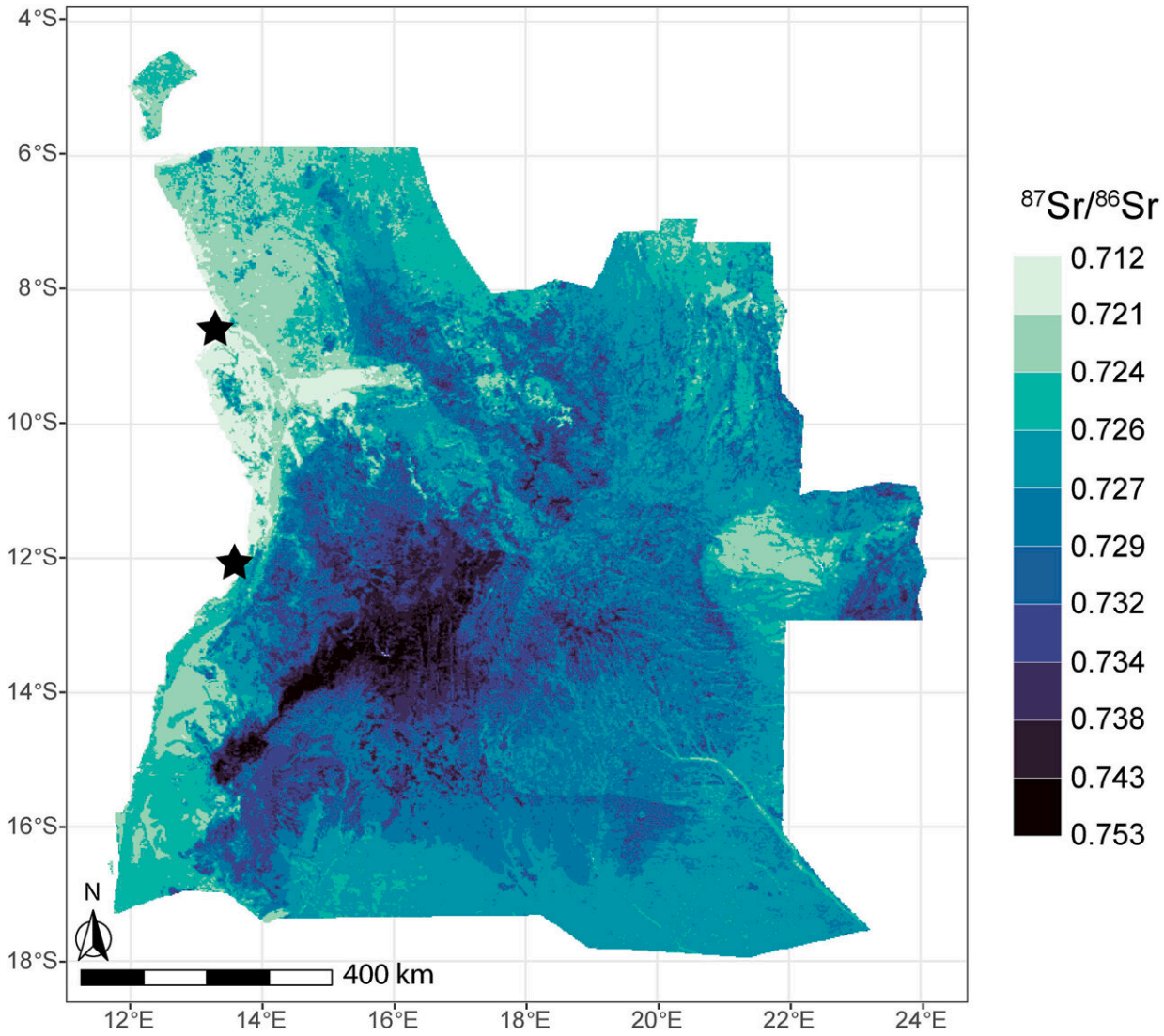
Strontium is an element present in soil that comes in several different chemical forms, called isotopes. The ratio of these isotopes to one another indicates the age and chemical composition of the bedrock in a given region of the planet. Plants at the base of the food chain take up strontium isotopes from the soil in ratios that can differ slightly from that of the bedrock or soil, and local animals then incorporate the strontium isotope ratios from plants into their developing bones and teeth via their diet. This means that the strontium ratio in certain parts of a person's body reflects the geology and environmental conditions of the place where they grew up.

Archaeologists can perform a stable isotope analysis on human remains to determine strontium ratios. Usually, those results then need to be used in combination with many other types of archaeological or historical evidence in order to make claims about human migration, since multiple regions can have similar strontium ratio profiles. But the UCSC team knew that Angola's geology was so unique that strontium ratios could potentially be used to identify an enslaved person who grew up in Angola with less additional evidence required.

Xueye Wang, lead author of the new paper, explained that Angola has ancient bedrock exposed at the surface on high plateaus near the center of the country, which gives the area very unique strontium isotope ratios. However, lack of samples from the broader region for use in stable isotope analysis has previously prevented archaeologists from pinpointing origins of human remains within Western Africa through strontium isotope ratios.

UCSC archaeologists overcame that challenge by contacting a group of German botanists that had been collecting plant specimens across Angola. The botanists gave researchers permission to perform stable isotope analysis on 101 herbarium plant samples. The team then used machine learning to combine the strontium isotope data from those

samples with information about elevation, soil characteristics, climate, and geological variables across Angola. The result was a predictive model that filled the gaps in isotope ratio values between sample sites in order to map out an "isoscape" of the entire country.



$^{87}Sr/^{86}Sr$ isoscape of Angola using random forest regression model. The scale of $^{87}Sr/^{86}Sr$ is classified by Fisher-Jenks natural breaks that optimize the variance within and between classes (Slocum et al., 2008). Credit: *Journal of Archaeological Science* (2023). DOI: 10.1016/j.jas.2023.105775

Using isoscapes to strengthen historical understanding

As a demonstration of the potential applications for their new map, researchers reviewed prior strontium isotope analysis of human remains in the Americas. Some prior studies had identified enslaved people who might be from Sub-Saharan or West Africa, due to their unique strontium isotope ratios. The research team focused particularly on four individuals, who had been buried in Rio de Janeiro, Brazil, the Caribbean island of St. Martin, the Mexican city of Campeche, and the Anson Street African Burial Ground in Charleston, South Carolina.

Using the new isoscape model, the team mapped out the most likely possible regions of origin for each person within Angola, based on their strontium isotope ratios. Researchers were especially successful in linking remains from Brazil and Mexico to very specific parts of Angola. This finding was consistent with historical knowledge about shipping routes in the southern transatlantic slave trade, said UCSC History Professor Gregory O'Malley, a co-author on the paper and longtime contributor to the Slave Voyages historical database.

Overall, Oelze said that the team's isoscape mapping methods provided significantly more detail and certainty on the African origins of first-generation enslaved people buried in the Americas than was previously possible through strontium isotope analysis work.

"In the past, archaeologists have often had to 'eyeball it' to say that the isotopes in human remains generally match what we'd expect to find in a particular region of the world," she said. "But with this study, we handed that question over to a predictive model that helped us quantify this in a much more scientifically rigorous way."

O'Malley added that this level of additional detail on first-generation enslaved people could help to answer lingering historical questions.

While ship logs provide a relatively detailed picture of how Europeans trafficked enslaved people from Africa to the Americas and within the Americas, it's more difficult to piece together where people came from before they reached the African coast. But those patterns within the continent had global impacts that linger to this day.

"The question of origins within Africa has crucial implications for tracing culture in the African Diaspora," he said. "What languages were people speaking? What religious beliefs were they carrying with them to the Americas? All of those kinds of questions require greater detail about where people were coming from within Africa. And this type of research could potentially offer us a really interesting way of getting at that question."

More information: Xueye Wang et al, A bioavailable strontium isoscape of Angola with implications for the archaeology of the transatlantic slave trade, *Journal of Archaeological Science* (2023). DOI: 10.1016/j.jas.2023.105775

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