Kasane Hot Springs Represents a New Geothermal Energy Source for Botswana

One of the Country's Top Universities Leads New Method to Explore Underground Energy Sources Using Geophysics Modeling Software

Located between two villages at the northwest tip of Botswana is the Kasane Hot Springs, a bubbling reservoir enjoyed by local residents for its spa-like waters. It is rumored that the springs have healing qualities for people who drink from them—although the government of Botswana officially says the mineral waters are not potable.

The springs are also a growing attraction for visitors to nearby Chobe National Park, which is home to diverse wildlife that includes lions, cheetahs, hippopotamuses, and the largest population of elephants in all of Africa.

Aside from the springs' cultural value to locals and as a point of interest for tourists, Kasane Hot Springs may have another hidden power. Calistus Ramotoroko, a researcher in geophysics at Botswana International University of Science & Technology in Palapye, Botswana, saw the springs' potential to become a geothermal energy source.

"We [want to] see if it's possible to assist [Botswana] by using geothermal energy, especially in rural villages, which are far from the city. We're trying to see any other possibilities other than electricity used by coal," Ramotoroko said.

In Pursuit of Power

For a country with growing pressure to maximize its energy independence, new energy sources would be welcome, particularly in relatively isolated areas like Kasane and Kazungula, the villages nearest the springs. The country's energy is distributed by a single utility, the Botswana Power Corporation, which has a network that does not yet extend to many of the country's rural villages, according to the International Trade Administration.

Already, Botswana's demand for power exceeds its currently available resources. It leans on petroleum products imported from other southern African nations, many of which are experiencing power shortages themselves. Botswana also relies on its own coal capacity; about 212 billion tons of coal are processed at the nation's two coal-fired power plants near Palapye.

As of August 2022, the International Trade Administration put Botswana's peak power demand at around 610 megawatts. While one of Botswana's Palapye power plants, known as Morupule B, technically has a capacity of 600 megawatts, it has experienced frequent outages and

closures and was only operating at 29% capacity as of July 2021. The recently restored Morupule A only contributes around 132 megawatts of power.

Considering these challenges, Botswana's government approved a plan in 2020 to shore up its energy supply, including bringing the proportion of renewable energy used to 15% by 2030. The country has already made strides in promoting solar energy through the new Rooftop Solar Program, which supports residents in installing solar panels on their own properties. Geothermal energy, on the other hand, has until now been an unexplored option in Botswana.

"While Botswana has undeniably good geothermal potential […] so far, this potential has remained completely untapped," Ramotoroko said.

Understanding the Springs

As Botswana's only confirmed hot springs, Kasane Hot Springs was the place that Ramotoroko was interested to start prospecting for geothermal energy potential. When he began his research, much was unknown about the nature of the springs beneath the ground. What caused the water to heat and bubble to the earth's surface? Ramotoroko began answering this question by talking to locals from Kasane and Kazungula, who had observed the springs for many years.

"The hot springs, where we see the bubbles and you see some steam come from underground, are located about 140 meters from the Chobe River. So, we think cold water somehow gets down through the fault in the river, gets heated up at deeper depths, and then, 140 meters from the river, comes back to the surface," he said. "[Villagers told me] they used to see bubbles within the river. So, the springs have a radius of maybe 200 to 300 meters."

To assess the depth and subterraneous qualities of the springs, Ramotoroko and his colleagues used an electromagnetic method called the magnetocaloric technique, which uses alterations in magnetic field changes to shift the temperature of materials. Additionally, the team performed spectral analysis to estimate the Curie point depth of the springs, or the depth at which rocks become magnetized. Ramotoroko discovered through this effort that the springs had a depth and heat flow conducive with geothermal energy production.

To map these findings, Ramotoroko turned to geoscience imaging software that he had previously used when studying mineral and diamond reserves for mining. The software allowed him and his colleagues to integrate surface and subsurface maps onto a single platform, along with interactive geophysical grids. His goal now is to develop a complete 3D model of the springs, both aboveground and belowground, that could be used to plan for drilling efforts. He hopes to secure grants that will finance an exploratory drilling mission, which should further reveal the geothermal potential of the springs.

Ramotoroko said that whatever energy comes from Kasane Hot Springs will likely be modest, as it is located over a stable plate and is not in a volcanic area. However, he hopes that it could

be valuable as a supplemental energy source for Kasane and Kazungula—and it may also serve as a jumping off point to explore further geothermal opportunities in Botswana and other African countries that are seeking renewable energy options. Already, he is curious to examine another site in Botswana where there are rumors that another hot spring may exist.

“Recently, I was speaking to someone from one of the villages in northwest Botswana, where there is the Okavango Delta. The guy said he has seen a hot spring there, so maybe after my research in Kasane, I’ll have to look into that,” he said.

Spotlight on Calistus Ramotoroko

Geophysicist pioneers method to explore geothermal energy potential from nation’s only known hot spring

Calistus Ramotoroko grew up interested in how the world around him worked, deeply curious about the mechanics of the earth beneath his feet. His path to becoming a professional geophysicist wasn’t quite straight, though; Ramotoroko entered a biomedical engineering program in Australia before attending the University of Botswana in 2007, where he leaned back into his passion.

“I decided to forget about biomedical engineering and do physics, to apply to [the study of] the earth, minerals, and water,” he said.

After earning his master’s degree in geophysics, Ramotoroko held roles with private companies out of Gaborone, Botswana’s capital and largest city. He worked with organizations that included Wellfield Consulting and Poseidon Geophysics, a company that offers exploratory services for diamonds, gold, and other metals. Within several years, however, he felt drawn back to academic research, where he could explore many different areas and concepts of geophysics.

Today, as a Ph.D. candidate and teaching instructor at Botswana International University of Science and Technology, he is focusing his research on a previously unexplored frontier for his country: geothermal energy. With the support of other faculty at Botswana International University of Science and Technology, including supervising Professor Elisha Shemang, Ramotoroko is exploring the potential of Kasane Hot Springs to supply power to households in the surrounding villages.

While diving into this untapped resource, the geophysicist is also pioneering new digital techniques for assessing geothermal potential. With software that was previously used by mining consultants in Botswana to map potential mineral and diamond reserves, Ramotoroko and his team have built geologic models with conceptual views of depths 200 kilometers into the

earth, along with integrated surface and subsurface maps. This technology allows experts to have a clearer picture of a spring's geothermal potential before beginning drilling.

For Ramotoroko, this cutting-edge project is an opportunity to be part of a growing push towards renewable energy in his country, which could bolster the nation's power capabilities and economy.

"I'm passionate, mainly because this is a developing country. It's interesting to work in [Botswana] and be part of its development," he said. "To be one of the first in Botswana to tap geothermal energy from this area is quite interesting. Nobody has done it before using the method that I'm using."

He also believes there will be rich opportunities to work in geophysics in Botswana in the future, both for himself and for young students hoping to enter the field. While mineral mining operations in southern Africa have traditionally served as an entry point for geophysics experts, Ramotoroko believes that his country and its neighbors will only strengthen their focus on renewable energy innovations as they look to diversify their energy resources—and for that, they may need geophysicists like him who can offer a view into the era.

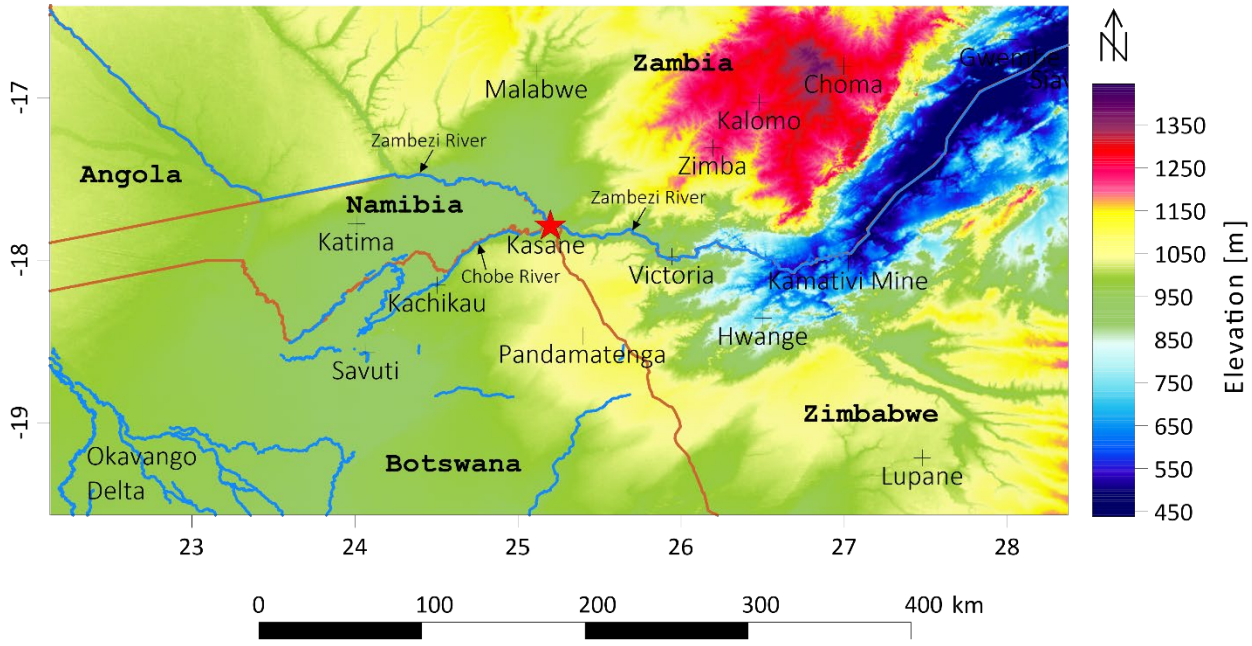

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Image Caption: Aside from the springs' cultural value to locals and as a point of interest for tourists, Kasane Hot Springs has the potential to become a geothermal energy source. *Image courtesy of Botswana International University of Science and Technology.*

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