

How to turn a volcano into a power station – with a little help from satellites

November 2 2017, by William Hutchison, Juliet Biggs And Tamsin Mather



Erta Ale in eastern Ethiopia. Credit: mbrand85

Ethiopia tends to conjure images of sprawling dusty deserts, bustling streets in Addis Ababa or the precipitous cliffs of the [Simien Mountains](#)

– possibly with a distance runner bounding along in the background. Yet the country is also one of the most volcanically active on Earth, thanks to Africa's [Great Rift Valley](#), which runs right through its heart.

Rifting is the geological process that rips tectonic plates apart, roughly at the speed your fingernails grow. In Ethiopia this has enabled magma to force its way to the surface, and there are over 60 known volcanoes. Many have undergone colossal eruptions in the past, leaving behind immense craters that pepper the rift floor. Some volcanoes are still active today. Visit them and you find bubbling mud ponds, hot springs and scores of steaming vents.

This steam has been used by locals for washing and bathing, but underlying this is a much bigger opportunity. The surface activity suggests extremely hot fluids deep below, perhaps up to 300°C–400°C. Drill down and it should be possible access this high temperature steam, which could drive large turbines and produce huge amounts of power. This matters greatly in a [country where](#) 77% of the population has no access to electricity, one of the lowest levels in Africa.

Geothermal power has recently become a serious proposition thanks to geophysical surveys [suggesting that](#) some volcanoes could yield a gigawatt of power. That's the [equivalent of](#) several million solar panels or 500 wind turbines from each. The total untapped resource is [estimated to be](#) in the region of 10GW.



Steam rising at Aluto volcano, Ethiopia. Credit: William Hutchison

Converting this energy into power would build on the geothermal pilot project that began some 20 years ago at Aluto [volcano](#) in the lakes region 200km south of Addis Ababa. Its infrastructure is currently being upgraded to increase production tenfold, from 7MW to 70MW. In sum, geothermal looks like a fantastic low-carbon renewable solution for Ethiopia that could form the backbone of the power sector and help lift people out of poverty.

Scratching the surface

The major problem is that, unlike more developed geothermal economies like Iceland, very little is known about Ethiopia's volcanoes. In almost all cases, we don't even know when the last eruption took place

– a vital question since erupting volcanoes and large-scale power generation will not make happy bedfellows.

In recent years, the UK's Natural Environment Research Council (NERC) has been funding [RiftVolc](#), a consortium of British and Ethiopian universities and geological surveys, to address some of these issues. This has focused on understanding the hazards and developing methods for exploring and monitoring the volcanoes so that they can be exploited safely and sustainably.

Teams of scientists have been out in the field for the past three years deploying monitoring equipment and making observations. Yet some of the most important breakthroughs have come through an entirely different route – through researchers analysing satellite images at their desks.

This has produced exciting findings at Aluto. Using a satellite radar technique, we [discovered that](#) the volcano's surface is [inflating and deflating](#). The best analogy is breathing – we found sharp "inhalations" inflating the surface over a few months, followed by gradual "exhalations" which cause slow subsidence over many years. We're not exactly sure what is causing these ups and downs, but it is good evidence that magma, geothermal waters or gases are moving around in the depths some five km below the surface.

Taking the temperature

In our [most recent paper](#), we used satellite thermal images to probe the emissions of Aluto's steam vents in more detail. We found that the locations where gases were escaping often coincided with known fault lines and fractures on the volcano.



A productive geothermal well on Aluto. Credit: William Hutchison

When we monitored the temperature of these vents over several years, we were surprised to find that most were quite stable. Only a few vents on the eastern margin showed measurable temperature changes. And crucially, this was not happening in synchronicity with Aluto's ups and downs – we might have expected that surface temperatures would increase following a period of inflation, as hot fluids rise up from the belly of the volcano.

It was only when we delved into the rainfall records that we came up with an explanation: the vents that show variations appear to be changing as a delayed response to rainfall on the higher ground of the rift margin. Our conclusion was that the vents nearer the centre of the volcano were not perturbed by rainfall and thus represent a better sample of the hottest

waters in the geothermal reservoir. This obviously makes a difference when it comes to planning where to drill wells and build power stations on the volcano, but there's a much wider significance.

This is one of the first times anyone has monitored a geothermal resource from space, and it demonstrates what can be achieved. Since the satellite data is freely available, it represents an inexpensive and risk-free way of assessing geothermal potential.

With similar volcanoes scattered across countries like Kenya, Tanzania and Uganda, the technique could allow us to discover and monitor new untapped geothermal resources in the Rift Valley as well as around the world. When you zoom back and look at the big picture, it is amazing what starts to come into view.

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