Predicting earthquakes weeks in advance is a nice premise, but we aren't there yet

April 30 2020, by Daniel S. Helman, Ph.D.

Major damage caused by an earthquake. Credit: Sunyu Kim on Unsplash - unsplash.com/@mauveine

For major earthquakes, the satellite predictions work. They give us enough warning, for example, to be able to stop a surgery safely before the shaking starts. A few seconds are critical in some situations. But to predict a large earthquake a week or more in advance takes something more. A research group in Greece has been working on detecting changes in the Earth's electrical environment, and have been hoping to make progress. What is interesting is that the changes they purportedly detect occur in the right time period—about ten days beforehand sometimes—to be useful. A recent update to their method prompted me to take a new look at their work.

Unfortunately, the premise is too good to be true. While the VAN method (named for professors Varotsos, Alexopoulos and Nomicos) is sensitive to changes in the Earth's electric field prior to earthquakes, it also produces an abundance of false positives. But all is not lost. Their method points to additional phenomena that might just help unlock the mystery of earthquake initiation. This is the conclusion I arrived at, now published in the May 2020 issue of the journal *Physics of the Earth and Planetary Interiors*.

Recently, scientists have been searching for an explanation for how groundwater changes are correlated with earthquakes. Not all earthquakes see a rise in well-water beforehand, but some certainly do. The timing is consistent with the timing of the seismic electric signals that the VAN group purports to study. But the mechanism for how these waters rise, and then fall afterwards is not well understood. The recent article summarizes the process and suggests that changes to the minerals in the surrounding rock liberate water from the minerals themselves. This is then incorporated into new minerals after the seismic event has occurred, thus lowering the level of the well-water after the event, and this matches observational data. The flow of water can also produce the purported electric signals at the strengths observed. And other groups, noticeably some researchers in Iceland, have done the difficult work of identifying the minerals before and after in at least one case. it seems a likely mechanism.

But there is another complication. Changes to the ionosphere, as sometimes occur during solar weather, are correlated with about half of the large earthquakes that occur. It isn't really feasible for ground-based processes to influence the ionosphere to match the changes, but it may work the other way around. The ionosphere may have a role to play in weakening the terrestrial rock via its influence on the geomagnetic field. It is still too soon to say whether this will be a useful path for earthquake prediction, but with the advent of machine learning, there may be a chance to explore some of these connections further. "How applied electricity or magnetism can influence crystal lattices to release volatiles from minerals, and whether this release can weaken rock sufficiently to support an electromagnetic earthquake trigger hypothesis are open questions," is what I write towards the end of the article. I plan to run additional tests of this approach via machine learning with various seismic and terrestrial data. One day soon we may be able to have a very good warning system in place that will allow for more than a week's notice, a vast improvement in public safety.

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More information: Daniel S. Helman. Seismic electric signals (SES) and earthquakes: A review of an updated VAN method and competing hypotheses for SES generation and earthquake triggering, *Physics of the Earth and Planetary Interiors* (2020). DOI: 10.1016/j.pepi.2020.106484

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