Volcanic eruption: Scientists perform volcanic scenarios to develop response plan

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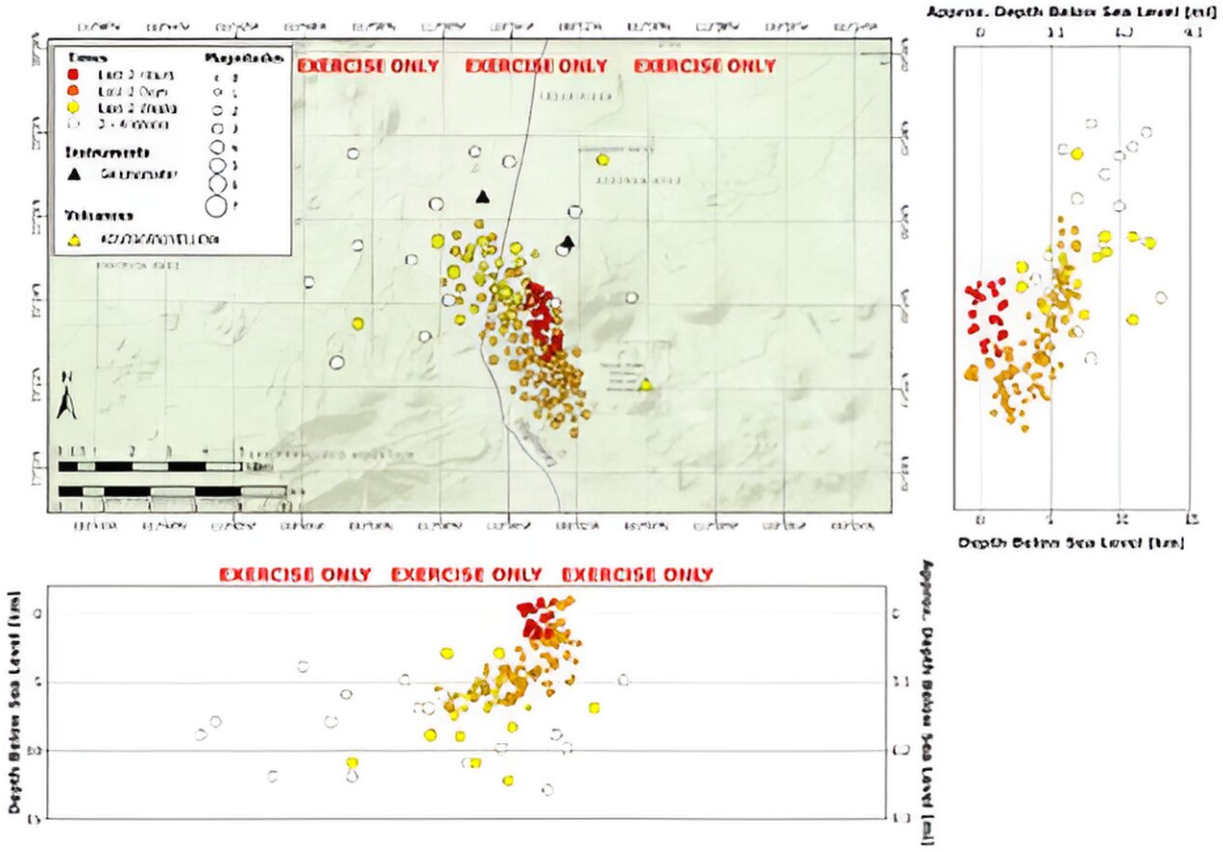

An example of the seismic information shared with the participants on February 15, during Stage 1 of the unrest. This example shows hypocenter locations on a map and in depth cross-sections and suggest a dike intrusion has occurred. Circle color indicates the time of each event, and circle size indicates magnitude. Credit: *Volcanica* (2023). DOI: 10.30909/vol.06.02.345366

What would happen if a volcano were to erupt tomorrow in New Mexico? How prepared as we as a society for an event like this to occur? When volcanic unrest occurs, both academic and government agencies need to have advanced fundamental understanding of the volcanic system with coordination before, during and after the event. This necessity has prompted the development of a response plan.

This is where the Community Network for Volcanic Eruption Response (CONVERSE) has created scenario exercises centered around a hypothetical volcanic crisis in Arizona's San Francisco Volcanic Field (SFVF) in the United States. The paper, "Lessons learned from the 2022 CONVERSE Monogenetic Volcanism Response Scenario Exercise" was recently published in *Volcanica*. The University of New Mexico's Yolanda C. Lin, lead author, and Tobias Fischer, co-author, helped to publish this research.

This project supported building connections among volcano scientists, both within academia and with governmental patterns such as the United States Geological Survey (USGS). These studies are critical for effective scientific response in case of an actual event of volcanic unrest. The effectiveness and impacts of these scenario exercises have not been well-studied. The exercise operated virtually from February 4 to March 4, 2022. The San Francisco Volcanic Field (in Arizona) was chosen in part because it offered a "different" type of response, as a field rather than a classic "cone" shape, and because it covers a variety of controlling bodies (US Government, tribal lands, private entities, and more).

"This research contributes to understanding how these types of scenario exercises develop a shared culture and sense of community within current and future volcano scientists," stated Yolanda C. Lin, Assistant Professor, Department of Geography and Environmental Studies.

That community Lin spoke of expanded quite literally due to the use of

online platforms to execute scenario exercises, which can be more inclusive (since no travel is required, and funding is limited), and can operate over a longer period of time since no actual field work is being conducted.

The Community Network for Volcanic Eruption Response (CONVERSE) is a geohazard center that represents all various disciplines in volcano science in order to make the best decisions. Tobias Fischer, UNM EPS Professor and lead Principal Investigator of CONVERSE, worked to to establish the center in 2022. An important aspect of CONVERSE is its partnership with the US Geological Survey. The main goal of CONVERSE is to maximize the science return from volcanic eruptions.

CONVERSE realized early on that practice was essential in order to understand the proper procedures to take, instead of waiting to study an eruption. To be efficient, these practice scenarios were vital in order to coordinate and collaborate on the findings.

The first scenario that the team examined was Mt. Hood, which is a volcano in the Cascades. It is currently not very active, but it does pose a real life threat to Portland and other major population centers. Out of this scenario came the idea of a scientific advisory committee that collects information and desires of people to work on the eruption and organizes the collaboration between scientists to achieve their goals.

"What we really want to do with CONVERSE is to open up the possibility for scientists that are perhaps not very well connected and who are maybe early career scientists who are just starting out. With the scientific advisory committee, we began implementing the process of allowing people to write a one-page proposal and send it to a committee of peers," stated Fischer.

With this scenario that CONVERSE orchestrated, the team decided to study volcanoes located in the southwest due to less activity, lack of monitoring, and no seismicity or gas emissions to prompt eruption concerns. However, as Fischer points out, there is a real potential for eruptions because those volcanoes erupted only a few thousand years ago, which is almost nothing within the geologic time frame. With this in mind, the team wanted to do something that would provide wide participation potential in an eruption, in a location not directly monitored by an observatory.

The scenario itself was developed by members of the organizing team, and the research was conducted by participant observation with a pre- and post- workshop survey, led by Lin and co-author and UNM student Ria Mukerji. The scenario exercise was a highly collaborative project that brought together expertise across a wide range of disciplines.

"As someone who focuses more on the use of scenarios in disaster preparedness, and who is not a volcanologist, this was a really exciting project for me to learn more from my colleagues in volcano science," stated Lin.

The experts came together and produced an artificial data set and an artificial timeline to simulate how this volcanic field might become active. This dataset included earthquakes that might be occurring, deformation that might begin at a certain time, and carbon dioxide emissions that could also arise during the ramp-up of the eruption. The team essentially simulated this and disseminated that information to the Yellowstone Volcano Observatory.

The team did this with several different disciplinary data sets and allowed everyone to see that data and provide input. The data sets allowed the researchers to identify volcanoes showing signs of deformation, signs of CO_2 emissions and increased seismicity. Based on

the information gathered, the team was able to predict which direction a lava flow would go.

"It was done in that way of virtually reproducing a scenario that could be realistic and allowing people to react to the information that could potentially be collected. Every week we had Zoom calls where USGS gave some updates, where the different disciplinary groups would give updates on what they think is happening, what their data shows," said Fischer.

The exercise helped consolidate resources related to volcanic field activity, and also produced open-ended questions that spurred new collaboration and discussion, both through the online discussion calls that were part of the exercise, and through proposals submitted by collaborative teams.

"With regards to understanding the role of virtual scenario exercises, we found that these experiences can be impactful and influential, and how the scenarios are conducted—including the types of interactions, and moderation of comments from all participants—is an important aspect of cultivating a culture of inclusivity in these exercises, and by extension, in volcano science," said Lin.

The 2022 CONVERSE exercise demonstrated how a hypothetical scenario can help broaden participation within a volcano science community.

The CONVERSE group is continuing with the scenarios and using them as an educational outreach process. In summer 2023 they held a workshop where M.S. students, Ph.D. students, and postdocs built another more complex virtual eruption scenario in order to create a realistic and internally consistent data set including deformation data, gas data and earthquake data.

The students also modeled the effects of the eruption, such as ash column heights, direction and size of mud flows, and other hazards. Students will be able to utilize this data set in future simulations to simulate the eruption scenario.

"We're increasing the complexity making it more and more realistic so that hopefully in the end we can actually make volcano models that are close enough to what might actually really be happening so that it can inform us directly on how volcanoes work," explained Fischer.

The researchers took away seven key lessons from this scenario, outlined in the published paper. One common underlying thread that stood out among all seven lessons focused on how the scenario exercise can better support inclusion in volcano science and eruption response.

As Lin explains, "Volcanoes have played a major role in shaping the landscapes of New Mexico and more generally in the Southwest, both physically and culturally. Though eruptions are relatively rare in the Southwest, there have been numerous eruptions in the past 10,000 years and the region is actively monitored for potential signs of volcanic unrest . Plus, volcanoes are just very cool."

More information: Yolanda C. Lin et al, Lessons learned from the 2022 CONVERSE Monogenetic Volcanism Response Scenario Exercise, *Volcanica* (2023). DOI: 10.30909/vol.06.02.345366

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