Highlights from the Fall 2023 American Geophysical Union Meeting

By Mara Reed

Every year in December, over 20,000 earth scientists get together for the largest conference in the geosciences. The chance to see and learn from colleagues is unparalleled, but big conferences such as these are an introvert's nightmare. The days are exhausting with back-to-back technical sessions, networking receptions, workshops, plenary talks, and town halls. If you block off time to rest, you feel a little guilty for not taking full advantage of all the conference has to offer—especially as attendance fees rise.

The American Geophysical Union meeting was held in San Francisco's sprawling Moscone Center this year. Being a local attendee is both good and bad. Since the conference was within a certain radius of UC Berkeley, I could not get compensated for meals, which provided another barrier to attending networking events invariably held at expensive restaurants. I do like sleeping in my own bed and foregoing air travel. However, commuting means you are up earlier and home later. From Berkeley, I would wake up early to beat the commuter rush on BART (the Bay Area's attempt at rapid transit), get off at Powell Street, and walk 10 minutes to the conference venue in a sea of conference attendees.

Thankfully, I presented my talk on the first day of the conference. This meant I could dispense with the public speaking anxiety early on and focus my attention on learning and networking. The best part of the week for me was definitely having lunch with most of the geyser-focused scientists based in the US and Europe, where we identified new opportunities for collaboration. I've written about a few highlights from the conference that I think might be interesting to geyser gazers.

Lessons from Diamond Open Access Journals

On the Sunday just before the official start of the conference, I attended a workshop on diamond open access journal building in the geosciences. The current state of academic publishing is pretty abysmal. Authors submit their manuscripts to journals, where a (usually unpaid) editor contacts (unpaid) expert peer reviewers to look at the paper and provide comments. This process of review, revision, and resubmission might go back and forth a few times before the manuscript is accepted for publication, at which point the authors pay the journal to have the paper published. If you have ample grant money, you can pay an additional open access charge so that the paper becomes freely accessible by all. Paying that open access fee might run you a few hundred dollars for smaller journals or a whopping $12,290 for publishing in *Nature*. The majority of scientists can't afford that, and unless there is an existing "transformative agreement" between your university and the journal that waives those open access fees, most will choose to pay the much cheaper base fee and their paper will remain behind a paywall.

The good news is that many scientists are fed up with feeding the profit margins of academic publishing companies. Several new community-run journals have popped up in the geosciences in the last decade that are built on diamond open access principles. That means there is no charge for authors to publish and no charge for readers to access. It was helpful to meet the scientists behind these journals and get a behind-the-scenes look at how they are created and maintained. I took a few lessons back that could be applied to our own *Transactions* and am sharing them with the editors.

Geyser Research: Yellowstone

Norris Geyser Basin disturbances.

Unfortunately, no one is documenting disturbances except for gazers who frequent Norris. Some Yellowstone scientists are not convinced they even occur, given the nebulous definition of disturbances and lack of "official" tracking. I decided to round up information from MA Bellingham and GeyserTimes on reported disturbance activity since 2013 so I could compare the timing to trends in seismic data from station YNM. Turns out there *is* a distinct, low frequency peak in seismic noise around the time of the first disturbance "symptoms" reported by in-basin observers or inferred based on temperature records from Steamboat and/or Whirligig. This lends evidence toward disturbances being a real, repeating event and may help us understand the mechanism that drives them. At least in the last decade, disturbances are occurring year-round, so the low water table hypothesis doesn't, erm, hold water. This research is ongoing and will become the last chapter in my dissertation. **Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1317175**

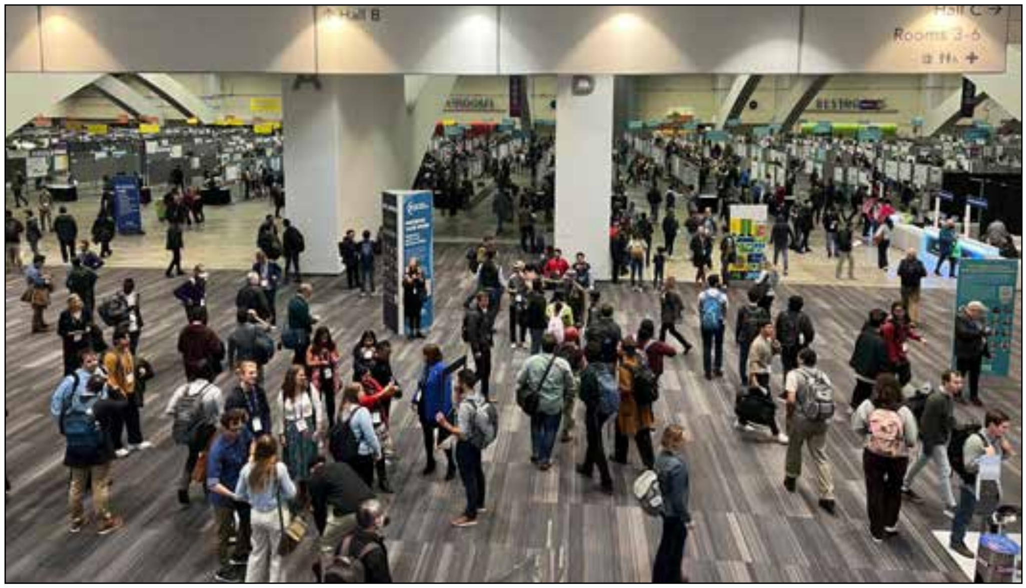
Predicting Steamboat eruptions.

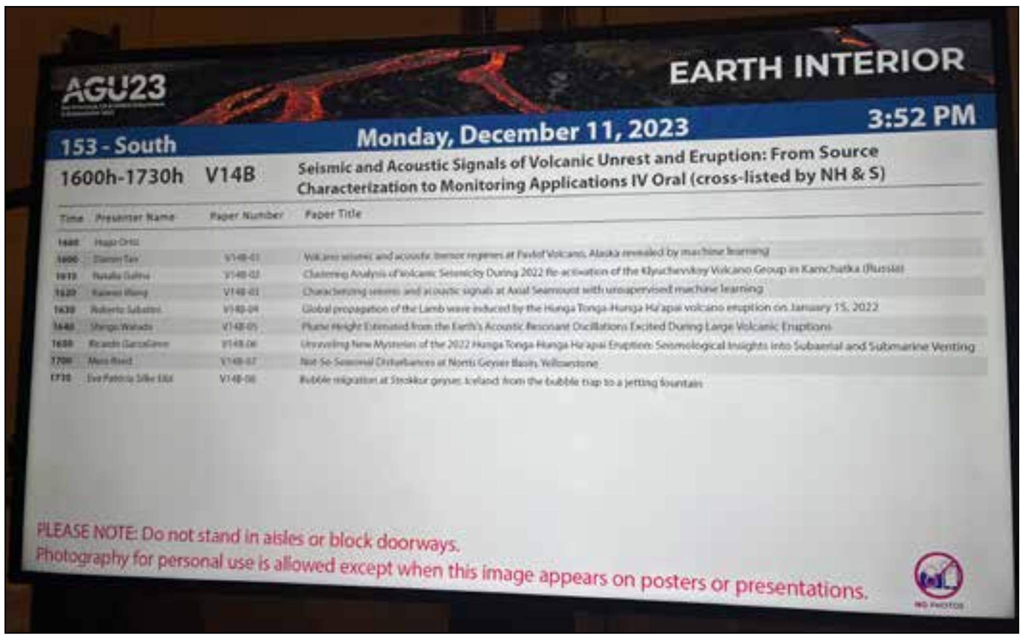
One of the postdocs in my lab, Anna Barth, is collaborating with earth scientists who specialize in machine learning models to see if Steamboat Geyser eruptions can be predicted just from YNM seismic data input. *Machine learning* is just a fancy term for statistical algorithms that characterize and find patterns in data. The benefit is that a computer program is usually better than a human at identifying patterns. The downsides are that the approach rarely tells you anything about physical mechanisms and the model can only classify things it has already seen in its training data. In short, this team's model is predicting eruptions at a rate better than chance, but there are still a lot of false positives and negatives. **Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1413978**

Water-rock interactions.

Geochemist types have long been curious about the distribution of springs in Norris Geyser Basin. Two features in particular have inspired a lot of research: the acidic "Red Bubbler" (pH=3) and the neutral-alkaline Perpetual Spouter (pH=7.5), which are separated by only ~45 feet. Ken Sims of the University of Wyoming presented on the culmination of years of geochemical sampling combined with more recent shallow ground imaging techniques.

Ken and his colleagues propose that the lead and radium isotope ratios in the water from these thermal features indicate water flowing to "Red Bubbler" interacted last with the Lava Creek tuff while water flowing to Perpetual Spouter interacted for hundreds of years with the deep sedimentary aquifer that feeds all of Yellowstone's hydrothermal areas. They also highlight that microbe populations both shape and are a consequence of the different ways water travels through and interacts with rock. The results of their geophysical imaging show shallow (~6 feet depth) flow paths from the Ragged Hills that bring cooler groundwater to both features.





Top photo: Just a fraction of the truly ginormous poster hall in Moscone Center in San Francisco. Bottom photo: Schedule for the oral session I presented at. Rarely do geyser folks get their own session—usually we are stuck haphazardly into volcanology sessions. Photos by Mara Reed.

Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1331414;
Related paper: https://doi.org/10.1016/j.gca.2023.10.021

What happened on Geyser Hill in May 2023?

For eight years, University of Utah researchers have placed temporary seismometer arrays in the Upper Geyser Basin to image Old Faithful's plumbing system and investigate the seismic noise associated with geyser basins. Cheng-Nan Liu, current graduate student, has been calculating the silence interval between thumps (i.e., the time between the end of one thumping period and the start of another) at Doublet Pool during these deployments. Unfortunately, no seismometers were deployed during the September 2018 weirdness on Geyser Hill when Ear Spring erupted, but we do know that the silence interval was between 20–25 minutes in late fall 2017 and had dropped to 12–13 minutes just a few weeks after the 2018 event onset.

In May 2023, a similar disturbance occurred on Geyser Hill, and the Utah researchers got lucky. One seismometer was deployed near Doublet Pool. Prior to 24 May, the average silence interval was ~20 minutes. After two anomalously long periods between thumping in the early morning, the silence interval suddenly dropped to ~7 minutes and within five days, slowly recovered to a slightly shorter silence interval of ~18–19 minutes. Further investigation of the seismic signals is ongoing—I'm particularly interested if there are signals similar to those seen at YNM during Norris disturbances. **Conference abstract**: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1346515; **related paper:** https://doi.org/10.1029/2022GL101175

Geysers in the lab.

In the early 1990s, pressure transducers dropped into Old Faithful found water level fluctuations at a characteristic frequency of 1 Hz. Similar oscillations on the order of seconds to tens of seconds are found at other geysers, too—and this means there is probably a relationship between the oscillations and plumbing geometry. Max Rudolph, professor at UC Davis, is part of a group building large-scale geyser models. In contrast to their previous experiments, this new work uses a lab geyser with hot water and steam for validation of a revised theoretical model that takes thermodynamics into account. (Why not start with hot water? As anybody who has built their own geyser knows, there are safety risks involved, and the team didn't want to work with a large hot water geyser until they could make the apparatus safer.) It seems their new model can explain the oscillations seen at Old Faithful where the upper plumbing geometry is known, which means there is now another potential method for estimating geyser conduit size.

A gathering of geyser researchers. Clockwise around the table, starting from the left: Carolina Muñoz-Saez (soon to be Cornell) and her son Galileo, Max Rudolph (UC Davis), Sin-Mei Wu (soon to be University of Hawai'i at Mānoa), Julia Gestrich (Ludwig-Maximilians-Universität München), Anna Barth (UC Berkeley), Michael Manga (UC Berkeley), Mara Reed (UC Berkeley), Shaul Hurwitz (USGS), Cheng-Nan Liu (University of Utah), Atsuko Namiki (Nagoya University), and Eva Eibl (Universität Potsdam).

Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1430012; **related paper:** https://doi.org/10.1016/j.jvolgeores.2018.11.003

Geyser Research: Elsewhere

Strokkur's blue bubbles.

Finally, someone is working on blue bubbles! That someone is Eva Eibl, professor at the University of Potsdam. Her study focuses on the physical aspects of blue bubbles (termed "water bulges" in her work) at Strokkur, Iceland including bulge height, ascent speed, and subsequent eruption height. Unsurprisingly, larger bubbles are associated with taller eruptions. Hopefully we will see a full paper published on this topic in the coming months!

Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1391018

Sounds and electrical fields of Pōhutu and Strokkur.

This work, led by Julia Gestrich, postdoc at the Ludwig Maximilian University of Munich, compares bursting Strokkur to jetting Pōhutu, New Zealand. At Strokkur, the acoustic signals span a large frequency range. As the bulge bursts, first infrasound (~0.1 to 20 Hz) amplitude peaks, then human audible sound, and then there's a distinct change in the electric field. Infrasound amplitude correlates with blue bubble ascent speed. In contrast, Pōhutu's jetting eruption has a narrow frequency peak around 50 Hz, there is pulsed infrasound, and the electric field disturbances are extremely weak. Julia and her colleagues also observed a relationship between interval and duration as well as alternating short and long intervals during their monitoring of Pōhutu in January 2023. Work is still ongoing, especially to figure out what mechanism causes the electrical signals.

Conference abstract: https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1301089