

Hi Reddit, I am Terri Woods of East Carolina University. Ask me anything about the aqueous geochemistry and/or using augmented reality to teach surface geology!

AmerChemSocietyAMA ¹ and r/Science AMAs¹

¹Affiliation not available

April 17, 2023

Abstract

ACS AMA Hi Reddit, I'm Terri Woods! I am an Associate Professor of Geological Sciences at East Carolina University (ECU). In 1971 I entered the University of Delaware with the goal of teaching high-school Spanish. Instead I became fascinated by how things work in the geological world and changed my major. While working on an MS at Arizona, I worked for the Anaconda Copper Company in Tucson and did mineral exploration with them in Montana. My thesis involved microprobe and fluid-inclusion work on a garnet skarn. I interviewed with mining/oil companies but got turned off by comments from interviewers such as; "We are looking for a few good gals". Luckily, I got another offer from the USGS in Reston, Virginia to work on the epithermal sulfide deposit at Creede, Colorado. I worked there for 3 years but my husband and I got tired of the DC area and went cruising on our 43-foot wooden sailboat. We ran out of money in St. Petersburg, Florida at a time when geology employment was hard to come by so I worked minimum-wage jobs until Bob Garrels (USF-Marine Science) asked me to run his lab. For the next 5 years I helped Bob with projects such as copper corrosion in sulfate, carbonate and chloride solutions; water chemistry in equilibrium with Australian BIF; C and S cycling through geological time, and compilation of thermodynamic data. I got my Ph.D. in 1988. That fall I started as a faculty member at ECU. I did lab work on copper corrosion, but students were into hydro-environmental studies so I began investigating the chemistry of water from local aquifers. That research continues, but I have also worked on the impact of reverse-osmosis brine discharge into Albemarle Sound, chemistry of nearby streams, and petrology of aquifer materials. I've devoted a lot of time to science outreach. Most recently, I have investigated a technology that helps people understand surficial processes and topographic maps - the Augmented Reality Sandbox: short demo video <https://mediasite.ecu.edu/MS/Play/ba30d1a13a684667ab155bfa58fd782a1d> longer educational video <https://mediasite.ecu.edu/MS/Play/e579f009dbca41e79f0d84d7207a714a1d> This past spring (2017), I was happy to serve as the scientific consultant for the ACS Reactions video "Why is the Statue of Liberty Green?" <https://www.youtube.com/watch?v=-ZSLrXtg1-o> So, Reddit, ask me anything about aqueous geochemistry, copper corrosion, or using augmented reality to teach surface geology. I'll be back to start answering your questions at 12pm EST (9am PST; 5pm UTC).

[REDDIT](#)

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AMERCHEMSOCIETYAMA [R/SCIENCE](#)

[ACS AMA](#)

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<https://mediasite.ecu.edu/MS/Play/ba30d1a13a684667ab155bfa58fd782a1d> longer educational video

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What exactly *is* aqueous geochemistry?

[✍ WRITE A REVIEW](#)

[MrWizardsTears](#)

CORRESPONDENCE:

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Geochemists use chemistry as their major tool for solving geological problems. High-temperature geochemists may study the elemental composition of meteorites or magmas to investigate how planets and the universe formed and evolved or to understand lavas that erupt at Earth's surface. Other geochemists study ore deposits to help us find mineral resources such as molybdenum and copper. Many geochemists study the composition of ancient rocks to learn about conditions on Earth over the course of Geologic Time – allowing them to predict future conditions. Alternatively, any geologist who

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focuses specifically on interactions between water and rocks, minerals, the atmosphere, organic matter, etc. can be considered an aqueous geochemist. Aqueous geochemists may research high-temperature environments such as the deep-sea hydrothermal vents along mid-ocean ridges or the minerals that form during the last stages of crystallization of magmas deep underground. However, many study interactions between near-surface water and the rocks and minerals through which it flows. The earth materials in the bed of a stream or those surrounding water slowly flowing underground can have a profound influence on the chemistry of that water. Geochemical hydrologists help us find sources of water and ensure our water supply is safe to use. They are also involved in cleaning water up if it becomes contaminated. I fall in the category of low-temperature geochemist because I focus on rock/water interaction at average earth-surface temperatures. I've studied the chemistry of river water and groundwater as well as the interaction between copper metal and water at 25oC.

Q-How do we "Purify" polluted bodies of water such as lakes/streams/the bay/ivers?

[rocker3k](#)

Unfortunately, it is not currently possible to purify large bodies of water that have been polluted. The best we can do is stop the influx of pollutants and allow the normal water flow to remove them from the water body. Flushing time is the time needed to replace the total volume of water in a "container" such as an estuary or lake. Flushing times for estuaries are typically on the order of days to weeks. Obviously, this does not destroy the pollutant it just moves it out into the ocean where, hopefully, it is diluted enough that it does not harm marine organisms. Flushing times for smaller water bodies such as ponds can be on the order of years and during that time the pollutant (e.g. nitrate) can cause significant damage to the pond ecosystem due to eutrophication. Groundwater pollution is sometimes remediated by pumping water out of the ground, purifying it, and pumping it back underground. As you can imagine, this is an extremely time-consuming and expensive process. Also, because groundwater travels "hidden" underground, and so much more slowly than river water, it may be many years before a pollutant shows up in wells or surface water. By then it is often impossible to determine the source of the pollutant so the taxpayer bears the cost of the remediation.

Do you ever use Theodolites?

And what is your favorite Geological instrument?

[Orav](#)

I have personally never used a theodolite, but many faculty in my department do. For me it has been enough to determine the latitude/longitude of my sample sites with a GPS unit and a topographic map. My favorite geologic instrument is a petrographic microscope. Although most of my work has involved water, I started out as a metamorphic petrologist and was totally fascinated by what could be learned about rocks and minerals in thin section. To make a thin section a thin slice of rock is cut using a diamond saw and then the slice is glued to a glass slide and ground down until light will pass through it. It is then placed on the stage of the microscope to be viewed at high magnification in either transmitted or reflected light.

Hi Dr. Woods,

Let me ask you a question on the public's meta understanding of geology. If someone were to ask you what's important about understanding aqueous geochemistry, what would you say?

What are the applicable benefits of your research?

[adenovato](#)

Geochemists use chemistry as their major tool for solving geological problems. Aqueous geochemists may research high-temperature environments such as meteorites, the deep-sea hydrothermal vents along mid-ocean ridges, or the minerals that form during the last stages of crystallization of magmas deep underground. However, many study interactions between surface and near-surface water and the rocks and minerals through which it flows. The earth materials in the bed of a stream or those surrounding water slowly flowing underground can have a profound influence on the chemistry of that water. They are also involved in cleaning water up if it becomes contaminated. I fall in the category of low-temperature aqueous geochemistry because I focus on rock/water interaction at average earth-surface temperatures. I've studied the chemistry of river water and groundwater as well as the interaction between copper metal and water at 25oC. Geochemical hydrologists help us find sources of water and ensure our water supply is safe to use. I think this is the major societal benefit of my discipline, although finding and developing adequate supplies of many mineral resources (e.g. iron, copper, lithium, rare-earth elements) also involves a lot of work by aqueous geochemists

What sort of feedback have you received about augmented reality to teach surface geology? What has been the key takeaway?

[adenovato](#)

Almost everyone who has ever seen the sandbox in person has described it as "neat" or "cool". College students in my geology labs actually called lab "fun" when we were using the sandbox to understand surficial processes and topographic maps. Thinks about that . . . "Calling a science lab fun". And these were not science majors. Young kids (K-5 especially) will play for hours and not even realize they are learning about connections between 2D and 3D representations of the real world and about how to interpret maps. They can also learn about water flow because of the virtual water part of the software. If you are interested you can read more details about our use of the ARS in college labs in the following paper published in the Journal of Geoscience Education:

2016 – Woods, T.L., Reed, S., Hsi, S., Woods, J.A., and M.R. Woods, Pilot study using the augmented reality sandbox to teach topographic maps and surficial processes in introductory geology labs – Journal of Geoscience Education, v. 64, p. 199-214

Our group has developed activities for using the sandbox in 3-12 grades, as well. Our 3-8 grade lesson plans have been used in a summer science-camp and will be improved as we continue that camp for 2 more summers. We have also given demos for many science outreach exhibits and groups of teachers. Almost everyone we ask agrees they can understand contour lines and maps much better when they can see the 3D version in the sandbox and the 2D version of the same terrain on the computer monitor.

Any time we can make learning science fun (and better yet "unconscious"), we advance the extent to which non-scientists can understand science.

What is reverse-osmosis brine discharge and what's the ecological impact?

[sciencereader3455](#)

Reverse osmosis is currently a common technique for removing salt from groundwater or surface water to enable us to use it as a source of drinking water. It involves using electrical power to push salty water through a filter to remove the salt and allow fresh water to come out the other side. It is a major

source of drinking water for the Outer Banks of North Carolina, where they use salty groundwater for the raw water feed. The "waste product" of reverse osmosis is very salty brine in which the salts removed from the raw water have been concentrated. Our study in Albemarle Sound and the Pasquotank River in NE North Carolina indicated no significant impact on water quality or the biota -- mainly because that environment is very dynamic and the brine should be diluted readily and rapidly around the discharge sites by mixing. This study was a combined effort between biologists and geologists. Our conclusion only applies to this type of dynamic environment and a situation where there are very few discharge sites. If the density of RO plants in our area increases this result would need to be reevaluated.

Okay I just watched the demo video and that's just awesome. I don't know how you get work actual work done.

Are you trying to get that technology into high schools? Middle schools?

[sciencereader3455](#)

We are currently working with several high schools and middle schools to introduce the technology into earlier grade levels than just the university. One nearby county has two boxes - one in their early-college high school and another at a nearby middle school. Our group has developed curricula for using the sandbox in K-12 as well as at the college level. Our 3-8 grade lesson plans have been used in a summer science-camp and will be improved as we continue that camp for 2 more summers. We have also given demos for many science outreach exhibits and groups of teachers.

When I was first developing the activities I spent many weeks just "playing" (Whoops - I mean working in the sandbox). It is a very intriguing technology.

Woah that sandbox aug reality is really neat! So what is copper corrosion and why is that a big deal?

[scienceaccount103040](#)

To get an idea of the nature of copper corrosion check out the youtube video for which I was recently the science consultant. < ACS Reactions video "Why is the Statue of Liberty Green?" <https://www.youtube.com/watch?v=ZSLrXtg1-o> > The importance is that vast amounts of very important objects are made out of copper: electrical wiring in virtually all buildings and plumbing in lots, naval vessels, electronic equipment, house roofs, etc. Understanding which corrosion minerals form in which environments (e.g., seawater, acid rain, fresh water, soils, etc.) allows engineers and materials scientists to develop corrosion-resistant forms of copper (and obviously other metals) that can most effectively and cheaply be used for these applications.

You mentioned having trouble finding jobs that used geology-related degrees; having worked in that field for a while, do you think that the outlook for these jobs has improved?

[odder135](#)

The time when I had trouble finding a job was 1980-1982. There were three main reasons for that: 1) The bottom had just fallen out of the base-metal market (prices were low and stockpiles were high) and mining companies were not looking for copper, lead, zinc to any great extent. 2) The price of oil was very low and the oil companies were laying off geologists. 3) The environmental regulatory and consulting segments had not really started to "heat up" as they have been doing for the past couple of decades. All these combined to put a lot of geologists out of work - especially a lot of my friends from

grad school at Arizona who wanted to do minerals exploration. Since then the US had been cleaning up a lot of environmental problems and trying to prevent future ones, producing much more of our own oil, and starting to look for additional metals (e.g. rare-earth metals, lithium, etc.) here in our country instead of relying on countries such as China for our supply. The outlook for jobs has improved substantially since then. I have been at ECU since 1988 and our MS grads have not had problems finding jobs - in fact, many of them have started their careers making more money than I am making as a tenured associate professor. I have no qualms about encouraging students to choose geology as a career. My son is a geologist working for a geotechnical engineering firm and he only has a BS degree. In larger markets (more heavily populated areas) geologists with solid academic records should not have much trouble finding a job. In small towns (< 30,000 people) it can be a little trickier.

Does the idea that NASA proposed about tapping into the yellowstone supervolcano for geothermal energy make sense?

[Tearakan](#)

There certainly is a huge amount of heat energy down there! I am not familiar with the NASA proposal, so I can't give you a very comprehensive answer. However, I think the US government may have answered that question in the late 1800's when they made Yellowstone a national park. I can't imagine the outcry that would arise if such development was proposed. In places like Iceland, I think they use this type of power to heat much of their water. And I believe New Zealand has a fairly well-developed system using geothermal energy to generate electricity, but I think there have been a lot of complaints about the negative impact on tourism in their hot spring areas. Just think what people would say if Old Faithful stopped erupting every hour or so? I could see agencies using Yellowstone as an example of the type of geological environment in which power-generation could be practical, but I'd like to think we won't start taking apart our most impressive national parks.