Answering Questions About Being a Professor
by Bill Menke, January 16, 2016

A correspondent asks:

> "Hello Mr. Menke! My name is Rashmina XXXXXX and I am a freshman in a high school in upstate New York. In my honors earth science class, my teacher assigned the class a project where I have to interview somebody in the earth science field. I am quite interested in seismology and would love to learn more! I will list the questions I need for the project below, but as I begin writing my paper I will probably have more. It would be great if you could take a few minutes out of your busy day to answer them. If you are interested, please respond within a week. Thank you!"

1. Describe what a professor in your field does.

I am a seismologist, meaning that I study "seismic waves" generated by earthquakes and other sources of shaking. Seismologists use seismic waves for two different purposes; to study the faulting process and to study the structure of the earth. Although I do both, my focus is on the latter, and especially on seismic tomography of the Earth's crust and upper mantle. This is the part of the earth that is especially important in governing plate tectonic processes. Much of my work focuses on the processes of mantle upwelling (the rising of hot mantle rock to shallower depths) and the volcanism that it causes. My goal is to understand this process in sufficient detail to be able to explain and predict its behavior.

Every scientist is in the business of learning new things and communicating his or her findings to the rest of the world. The process of "learning" is multifaceted, and involves collecting new data, looking for patterns in them, constructing models capable of predicting the patterns, understanding the implications of the model - what , in a nutshell, it tells you about the earth. The process of communication involves presenting the results of research at scientific meetings, writing them up as an article in a scientific paper (both of which are primarily directed at other scientists) and talking with the press and other non-scientists to give them a non-technical understanding of the result.

My most recent project was focused on the mantle beneath northeastern North America, the area that includes New York, New England and Quebec. The Quebec region is among the oldest on earth, with rocks as old as three billion years. The New York / New England part includes the Appalachian Mountains, which at 0.4 billion years old, are comparatively young. My interest is in how the age difference affects the Earth's mantle. In order to address this interest, I put together a team of the three like-minded seismologists and convinced the National Science Foundation (a US Government agency) to lend us about thirty seismometers that we could deploy in Quebec and northeastern US and give us enough money (about half a million dollars) to operate them for three years. Convincing them wasn't easy; we wrote up and submitted many

versions of the project before it was approved. We then spent a summer deploying the seismometers. Here's a picture of me, decked out in mosquito netting, building the enclosure for a seismometer in Maine:

http://www.ldeo.columbia.edu/users/menke/slides/QMIII_A12/QMIII_A12_97.html

We spent the next couple of summers servicing the seismometers (swapping out the flash cards that recorded the data, changing batteries, etc). Last year, we began to analyze the data. We found something very interesting; the mantle beneath southern New England is upwelling very strongly. After considering many possible cases for the upwelling, we believe that we understand the reason, which has to do with the age – and hence temperature -difference between the very old and the younger ones causing convection cell to develop in the mantle. We wrote this idea up in a article in Geophysical Research Letters; I attach a copy so you can get a sense of what a scientific paper is like. Because of the link between mantle upwelling and volcanism, our article attracted the attention of some popular science websites as a couple of newspapers. I was interviews by them, answering questions about the possibility of a volcano erupting in New Hampshire.

But you use the word "professor", as contrasted to "scientist". I am both, but the word professor emphasizes my link to a university – Columbia University in the City of New York, in my case. What a professor does is complicated, but often summarized as research, teaching and service.

I've already told you about my scientific research side. I also teach courses, both at the undergraduate level (students hoping to earn a baccalaureate degree) and the graduate level (students hoping to earn a doctoral degree). I'm given different teaching assignments from year to year. Lately I've been teaching include "The Solid Earth System (SES)" to undergraduates and "Quantitative Methods of Data Analysis (QMDA)" to graduate students. SES is an introductory course that covers plate tectonics - processes like volcanism, mountain building and erosion - that create and modify the rocks in the earth's crust, and earth resources such as petroleum and ores. QMDA is an advanced course on data analysis techniques and is very mathematica. I wrote the textbook (another form of teaching, you could say):

https://www.elsevier.com/books/environmental-data-analysis-with-matlab/menke/978-0-12-804488-9

I also supervise graduate students who are doing their own seismological research (and that will become their Ph.D. thesis, which is one of the requirements of the doctoral degree).

Finally, the term "service" is used in the sense of helping to run the university, by serving on committees like the Personnel Committee (which supervises the department's non-professorial employees), Search Committee (which hire new professors) and the Examinations Committee (which oversees student exams). Much of

this work is very 'political' in nature. I am very good at it, but thirty five years of it has taken an emotional toll.

2. How do you use earth or environmental science to do your job?

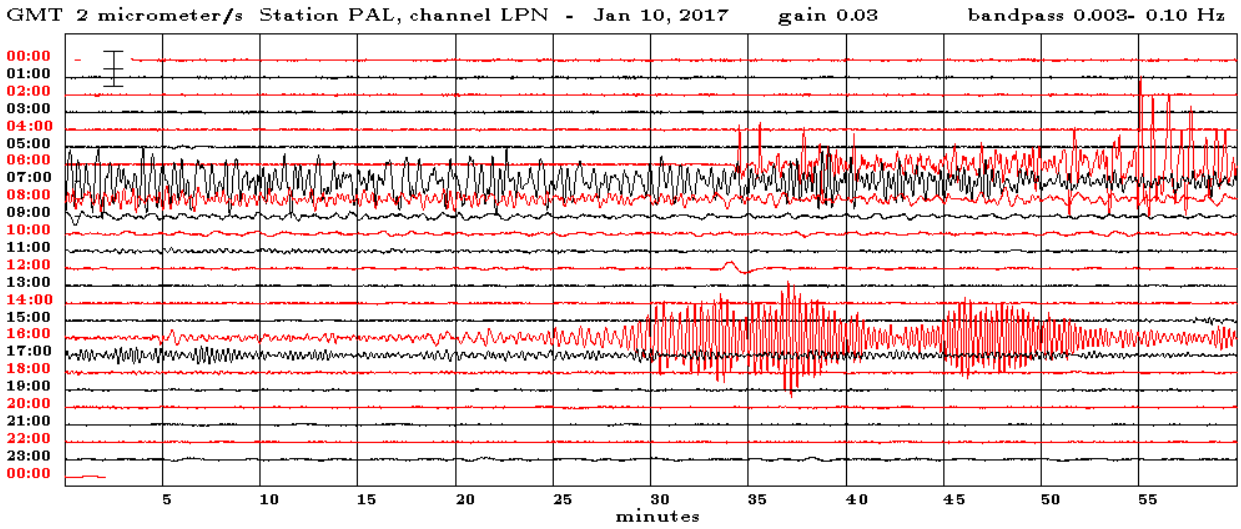
Everything I have ever learned I employ as a tool to learning something new. I often work on a problem for a while, put it aside when I get stuck, and then return to it later – maybe years later – when I get a new idea or when somebody else publishes something that suggests a way forward. I have an electronic notebook in which I keep track of 'little ideas':

http://www.ldeo.columbia.edu/users/menke/research_notes/index.html

Sometimes they come in handy when I'm working on the 'big idea'.

I know a great deal about certain areas of earth and environmental science, but am always asking myself when something I think I know is wrong; that is, when new data I come across suggest that something I've been taught is not quite right. To me, it's a signal to *pouce*.

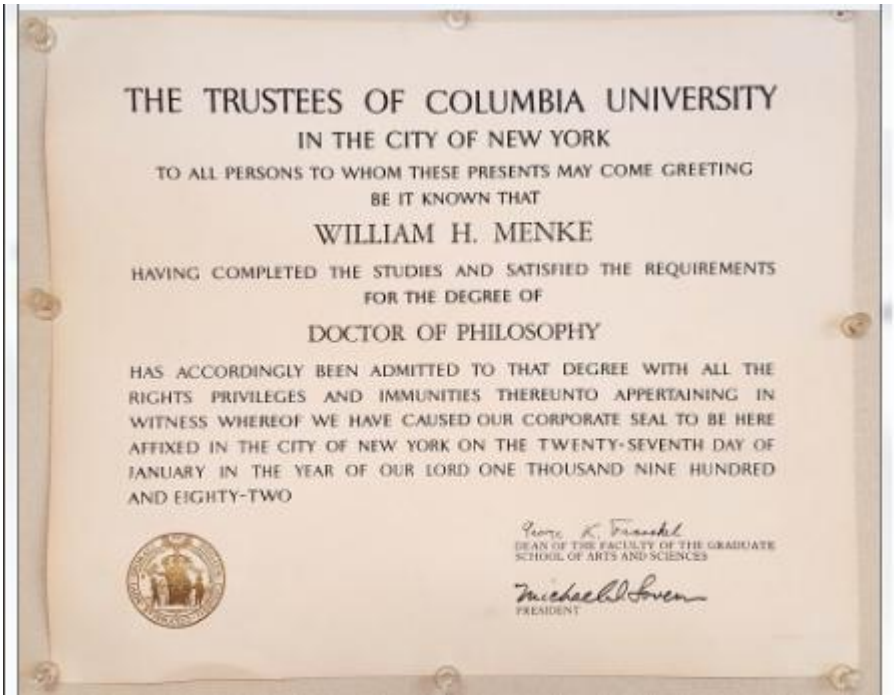
Much of my career is built on my ability to find meaningful patterns in seismograms, that is, plots of wiggly lines that encode ground motion. Here's the ground motion in Palisades NY for January 10, 2017:



Two magnitude six-ish earthquakes occurred this day; the first is a deep earthquake in the Andes, the second in shallow earthquake in the western Pacific. That much I can see just from looking at the plot. I suppose you could say this skill is a bit like a raidologist's, who can interpret an X-ray that you or I might think just a grey blur.

3. What kind of education or training is required?

I have a Ph.D. in seismology from Columbia University, which I earned in 1982. Here it is:



THE TRUSTEES OF COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK
TO ALL PERSONS TO WHOM THESE PRESENTS MAY COME GREETING
BE IT KNOWN THAT
WILLIAM H. MENKE
HAVING COMPLETED THE STUDIES AND SATISFIED THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
HAS ACCORDINGLY BEEN ADMITTED TO THAT DEGREE WITH ALL THE RIGHTS PRIVILEGES AND IMMUNITIES THEREUNTO APPERTAINING IN WITNESS WHEREOF WE HAVE CAUSED OUR CORPORATE SEAL TO BE HERE AFFIXED IN THE CITY OF NEW YORK ON THE TWENTY-SEVENTH DAY OF JANUARY IN THE YEAR OF OUR LORD ONE THOUSAND NINE HUNDRED AND EIGHTY-TWO
DEAN OF THE FACULTY OF THE GRADUATE SCHOOL OF ARTS AND SCIENCES
PRESIDENT

Doing serious science today requires graduate training. There's a lot you have to know.

4. What might the job outlook look like over the next ten years?

I would say that the overall outlook is weak but some niche areas might have greater potential.

There will be a steady trickle of openings for doctoral level scientists in academia and government, but employment in these sectors is not growing and the competition for jobs is intense.

5. What are some pros (advantages) and cons (disadvantages) of your career?

The high points of being a professor – making a scientific discovery, helping a student succeed and seeing him or her graduate, even serving on a committee that accomplishes something useful, like working with a designer to refurbish a classroom – are very rewarding and they come sufficiently often that I want to continue doing the job.

The low points – having a project repeatedly turned down for funding, having to fail a student, having a bunch of your fellow professors furious with you because they disagree with a decision you've made – are real bummers. Too many of those in a row and I start telling myself that I need to retire.

My schedule is very flexible. Except for showing up to teach my classes and attend the occasional meeting, I can come and go as I please. If I hopped on a plane tomorrow and went to Caltech to chat with one of my buddies there, no one at Columbia would complain. On the other hand, I have many responsibilities and expectations, and frankly, probably too much self-motivation. Why else would I be writing up this answer at 11 PM on a holiday?

A few years ago I wrote up a tongue-and-cheek job description that describes how I allocate my time:

http://www.ldeo.columbia.edu/users/menke/vita/jobdes.pdf

The joke is that each of research, teaching and service is designated as 75% of my time.