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Environmental geophysics

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Explaining what we do

Welcome readers to this issue's column on geophysics applied to the environment. This month's column isn't so much about environmental applications of geophysics, but is about something that I think about pretty often (and is as pertinent to environmental geophysics as much as to any other branch of our science). How do you explain what we do to civilians, i.e. to people not immersed in our dark art/science?

In the following paragraphs I present a few of the explanations that I have tried in the past. My apologies if any of this sounds condescending, but I think what we do is really kind of weird, even to the electrical engineers that I have spoken to: at least they have some background in electricity (sorry to my not-electrically oriented friends – you will just have to think in parallel for the rest of this column). The point though is that I think that it is important as scientists, specialising in geosciences, and then specialising further into geophysics, that we make what we do accessible, especially to kids. You never know what will get a young person interested – in a career that they never knew existed.

Many years ago I was running a survey on the River Murray using shallow TEM to map the sediments (and accompanying salinity) from the surface of the river to a depth of about 20 m (by the way most of water in the river is about 20 ohm-m), dragging the EM antenna behind a small houseboat. The skipper of the houseboat decided on a Sunday morning that I should talk to Macca on ABC radio and tell him about the good work that we were doing (the project was mostly about mapping the proximity of saline groundwater to the base of the river in order to help with evaluating the effectiveness of salinity reducing schemes on the river and floodplains). Anyway, Macca gave me lots of stick for having such a strong American accent after living in Oz for so long (at that time I'd been in the country >15 years). Once we got past that he did want to know what we were doing and how it worked… And then I gave some variation of the explanation that I give to whoever is asking (usually in more detail than they are interested in).

Well you know, it's a little like seismic (for some reason most people have some understanding of seismic surveys), where they set off small explosions on the surface and you get an idea of what's down there by how fast the sound waves go through the earth and the layering that they bounce off of, but instead you use electricity. We put a little (sometimes a lot of) electricity into the ground to kind of light up the parts of the ground that are more or less conductive than other parts of the ground. Sometimes it's the geometry of the setup that helps you determine depth, and sometimes it's some property of the electricity itself. Sometimes I talk about the frequency and that high frequencies see shallow and low see deep; if someone looks really interested (chuckling at my desk thinking of some poor innocent listening to my crazy rants) you can do TEM loops and smoke rings descending into the Earth. And then something about treating the Earth as a big electronic engineering problem with the ground acting like masses of resistors and conductors, mix in few inductor and capacitors, etc. and you get the picture. I kind of got the point across I think. Geez I hope I didn't go through all of that for poor Macca.

Anyway, I got some calls and emails over the next few days about that interview from friends in the biz, saying that my explanation mostly worked. LOL. So that's kind of my spin on how I explain to most people what I do.

And then there is nuclear magnetic resonance – NMR. I have no idea how to describe NMR to 'normal' people. It's weird enough to me that NMR is a kind of a strange combination of quantum physics (protons have a quantum property called spin, an even number of protons in the nucleus of a given molecule = no net spin in that proton while an odd number of protons = net spin) and classical physics. We can mostly align molecules with net spin (molecules with odd number of protons…) with another bigger magnet, and then can bang them away from that alignment by using an alternating magnetic field at just the right frequency, and then turn the AC source off and the darn little magnets take some time to realign with the big magnet. And what do you get when you move magnets? An E-field, detectable using – classical, old-fashioned, based-on-Maxwell's-Equations physics (i.e. a magnetic sensing coil). By coincidence hydrogen is pretty ubiquitous in the crust (think water) and by another amazing coincidence has just one proton (the first odd number), so has a magnetic spin that can be aligned, and measured. So we can detect water in the crust if we are able to align those hydrogens in the water to an external static magnetic field (the Earth's magnetic field is usually sufficient) and a loop on the surface that we can energise at that right frequency.

Turn this logic around slightly and fill a portable 'cavity' with something like petrol (i.e. hydrocarbons that have more hydrogen than water) and you've got a proton precession magnetometer. Build really really big magnetics and set them up in a frame so they can be rotated around a test material and you have – an MRI (yes to a large extent MRI's work by mapping the variable water content in your body). Etc. Still, hard to explain.

So the upshot is that I am curious if anyone out there deals with this on a regular basis – and if so, feel free to let me know how you describe what we do. If I get enough responses I'll combine them into another column sometime out there in the future.