a LOW-COST earth’s field NMR SEnsor protype for hydrogeophysical applications

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Hydrogeophysical methods are being increasingly relied upon by the community. In particular, electrical resistivity tomography (ERT) and electromagnetic methods provide valuable imaging of subsurface electrical conductivity. Electrical conductivity is known to vary as a function of lithology, saturation, and water quality. All three of which may be varying and of interest in an application. For this reason, the interpretation of electrical conductivity sections is often ambiguous and requires additional information.

Nuclear magnetic resonance methods utilize the paramagnetic properties of liquid-phase water molecules to unambiguously detect the amount of liquid water in the subsurface. Such information can be invaluable in the interpretation of electrical conductivity models. Earth’s field NMR methods rely on the Earth’s natural magnetic field for polarization of water molecules and is therefore the simplest and lowest cost NMR method in geophysics. However, most Earth’s field instruments utilize large transmission loops of wire that do not provide spatial resolution commensurate with typical ERT surveys. Many of these instruments are also prohibitively expensive and heavy for backcountry applications.

To address these concerns, this project aims to develop low-cost NMR sensors based on open-hardware and open source software practices. Specifically, an open-hardware spectroscopy instrument developed by the University of British Columbia is being adapted for geophysical applications. The sensors utilize Ardiuino microprocessors and coding environments in addition to commodity electrical components to keeps costs well below $300 USD. Data acquisition is accomplished using a Raspberry Pi System on a Chip (SOC) which is additionally low-cost. While still in prototype stage, final version of the sensor could be left in place for continuous monitoring of field sites.

We present in this poster preliminary data from the developed NMR sensor as well as motivating ERT data from an ongoing site investigation at the Judith River Watershed in SW Montana. The project is funded from a SEED grant as part of the NSF-funded Consortium for Research on Environmental Water Systems (CREWS) project.