**INTRODUCTION**

The Magnetic Resonance Sounding (MRS) Method allows for the direct quantification and characterization of non or weakly bounded water in near surface soil. MRS measurements in densely populated areas, frequently cause S/R ratios of less than 1. This is why last year we have added a transmitter for the pre-polarization (PP) of the soil (RADIC & COSTABEL, 2017) to our MRS apparatus MRS-MIDI-III (RADIC & LEHMANN, 2011). A field of 500 mT can be generated for several seconds within the 2 metre PP-Loop. In doing so, the nuclear magnetisation of the water within the upper 1-2 metres increases up to one magnitude. The directly following “conventional” MRS measurement then stimulates an up to 10 times greater response signal (FID).

Recently we have added a further innovation to our instrument: an adiabatic pulse (AP). A Tx pulse to deviate the protons in the soil is normally constant in regards to frequency and amplitude. However, this causes zones, which lie closely next to each other and which have different negative or positive values of sensitivity. As a consequence, signals are reciprocally cancelled out and the useful signal measured at the surface is weakened. The specific characteristic of adiabatic pulses is that the frequency and/or current change during the pulse. Through this, the distribution of the sensitivity in the soil can be advantageously influenced (Grunewald et al., 2016). Amongst others things, it is therefore possible to achieve an approximately homogeneous distribution of the sensitivity in a defined depth range, which avoids reciprocal cancelled out signals and increases the signal amplitude by a factor of up to 3.

**ADIABATIC PULSES**

Figure 1 shows three fundamental types of adiabatic pulse forms. 7 parameters are enough to exactly specify all 3 types of pulse in their chronological sequence. One parameter determines the length, the others the pulse forms. Frequency and pulse strength sequences can be determined independently from one another. The pulse strength is determined by the Duty Cycle (DC). The DC is, in a good approximation, proportional to the pulse strength.

**THE INSTRUMENT**

Figure 2 gives an overview of the measuring system MRS-MIDI-III++. A laptop controls the entire instrument through its USB port. At the heart of this is the Base Unit, to which the Tx and the PP transmitters (Px) as well as up to 7 receiver channels (Rx) can be connected. The Tx and the Rx loops are required as a minimum for the MRS measurement. A Px loop with up to a 2 metre diameter can be connected additionally to explore the upper meter. Two further loops serve to monitor noise and suppress noise components in the FID signal (Reference Technique). Figure 3 shows the user interface of our measuring device. The numeric input of the 7 parameters are located in the upper right corner of the monitor (line card: 1x). The resulting nominal process is immediately calculated and shown in the graph below as a continuous line. The evaluation of the in the following measured current (lower left graphic) then gives the actual progression of the frequency (red dots). The transmitter signal voltage has the shape of a square. This signal shape shows, as opposed to a sinus, advantageous qualities because technically it can be generated more easily and there is less heat loss. The pulse strength is determined through the choice of the ratio of the on/off time (the Duty Cycle). In contrast to excitation voltage, the resulting excitation current has the shape of a saw tooth as a result of the inductivity of the Rx loop.

**FIRST FIELD TEST**

A first field test with adiabatic excitation was carried out at our test site in Linum (close to Berlin). A Tx and a Rx loop were used each with a 10 m x 10 m side length. The Tx loop had one turn, the Rx loop had 12 turns. The Reference Technique was used for improved noise suppression. In addition, the time series were stacked 8 times. The excitation pulse length was in each instance 35 ms. Figure 4 shows that the adiabatic excitation, as expected, caused a stronger NMR signal as a conventional excitation. The average amplitude of the FID (Free Induction Decay) is increased by 20%, the initial amplitude (E0) by 52%. It is also striking that the relaxation time T2* of the adiabatic excited FIDs is significantly shorter (167 ms) than those of the conventionally excited FIDs (258 ms). Presumably the broadband adiabatic excitation causes shorter T2* times in the not fully homogenous Earth’s magnetic field.

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**REFERENCES**


