



## Magnetic Resonance Imaging Methods in Soil Science

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Magnetic Resonance Imaging (MRI) is a powerful technique to study water content, dynamics and transport in natural porous media. However, MRI systems and protocols have been developed mainly for medical purposes, i.e. for media with comparably high water contents and long relaxation times. In contrast, natural porous media like soils and rocks are characterized by much lower water contents, typically  $0 < \theta < 0.4$ , and much faster T1 and T2 relaxation times. So, the usage of standard medical scanners and protocols is of limited benefit.

Three strategies can be applied for the monitoring of water contents and dynamics in natural porous media: i) Dedicated high-field scanners (with vertical bore) allowing stronger gradients and faster switching so that shorter echo times can be realized. ii) Special measurement sequences using ultrashort rf- and gradient-pulses like single point imaging derivatives (SPI, SPRITE)(1) and multi-echo methods, which monitor series of echoes and allow for extrapolation to zero time(2). Hence, the loss of signal during the first echo period may be compensated to determine the initial magnetization (= water content) as well as relaxation time maps simultaneously. iii) Finally low field (< 1T) scanners also provide longer echo times and hence detect larger fractions of water, since the T2 relaxation time of water in most porous media increases with decreasing magnetic field strength(3).

In the presentation examples for all three strategies will be given.

### References

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- 2) Edzes et al., *Magn. Res. Imag.* 16, 185-196 (1998)
- 3) Raich H, and Blümner P, *Concepts in Magn. Reson. B* 23B, 16-25 (2004)
- 4) Pohlmeier et al. *Magn. Res. Imag.* doi:10.1016/j.mri.2008.06.007 (2008)