Tomography of soil-root-water processes

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The study presents the theory and potential applications of both x-ray and thermal neutron tomography and evaluates its sensitivity, with particular attention to using this technique for the measurement of small-scale spatial and temporal variations in measurements of soil moisture, soil solute concentration and transport, and root water uptake. After introducing theory and error analysis, results of a x-ray microfocus CT experiment are presented, emphasizing the need to correct for beamhardening, and describing the inherent spatial variability of solute breakthrough through an glass bead porous medium with an effective spatial resolution of approximately 85 micrometer. A single root water uptake experiment with a corn (*Zea mays* L.) seedling demonstrated the successful application of neutron computed tomography (NCT), with images showing spatially variable soil water content gradients in the rhizosphere and bulk soil. Although NCT techniques are routinely used in engineering, relatively little is known about their application to soils. Neutron imaging works especially well for substances that contain hydrogen atoms such as water, or other low atomic mass, neutron attenuating materials. The neutron source in this study was a Mark II TRIGA Reactor at McClellan Nuclear Radiation Center (MNRC) in Sacramento, CA. Continued research and instrument development is needed to improve the spatial and temporal resolution of the NCT measurements, including to investigate the application of isotopes in combination with NCT to study plant nutrient uptake processes.

Microbial activity in terrestrial mud volcanoes from the Northern Apennines

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Methane seeping mud volcanoes can be observed in terrestrial and marine settings worldwide, mostly localized in tectonic zones of compression [1, 2]. Especially for seafloor sites it is known that several types of archaeal and bacterial microorganisms metabolize hydrocarbons from gas and fluid phases. In particular, methane is oxidized under anaerobic conditions (AOM) by anaerobic methane oxidizing (ANME) microbial consortia.

Here we describe the microbial communities in mud volcanoes of the Northern Apennines. The mud volcano fluids contain dissolved and suspended material from sediment layers dating back to the Messinian event. Thus, the mud volcanoes represent an anaerobic mesohaline environment. Though, on average, microbial cell counts were lower than 10^4 ml^{-1} in mud volcano fluids, several isolates of sulfate reducing and fermentative bacteria could be obtained and were studied in detail. In fluid samples, methane dependent sulfate reduction under anoxic conditions due to microbial activity could be detected. Diversity of archaeal groups was studied by analysis of rDNA clones obtained from environmental DNA and revealed, *inter alia*, the presence of ANME 2a-related archaea. The organisms were present as single cells and small aggregates, as revealed by fluorescence *in situ* hybridization of fluid samples.

A structural-functional comparison of mud volcano microbial communities with microbial mats from marine methane seep sites points out the similarities and differences of biotopes fueled by methane as primary energy source.

[1] Alain *et al.* (2006) *Environ. Microbiol.* **8**, 85-91. [2] Reitner *et al.* (2003) *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **277**, 18-30.