Two-Dimensional Model of Unsaturated Water Flow and Equilibrium Carbonate Chemistry. J. ŠIMUNEK and D.L. SUAREZ, U.S. Salinity Laboratory, USDA-ARS, Riverside, CA.

Modelling the transport of major ion concentrations in and below the rootzone plays a critical role for irrigation and water quality management. We present a two-dimensional model which includes water flow and heat and multicomponent transport in a variably saturated porous media. Ca²⁺, Mg²⁺, Na⁺, K⁺, SO₄²⁻, Cl⁻, and CO₃⁻ were considered as major components of the chemical system. We account for equilibrium chemical reactions between these components such as complexion, cation exchange and precipitation-dissolution. Considered solid phases were calcite, gypsum, hydromagnesite and nesquehonite. We also include the temperature dependence of all major equilibrium constants. Since the ionic strength of the soil solution varies considerably with time and space, both modified Debye-Hückel and Pitzer equations were incorporated into the model to calculate ion activities. The utility of the model is demonstrated using simulations with subsurface irrigation.

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Water Movement in Swelling Media DE SMILES, CSIRO Division of Soils, Australia.

Theory of flow of water in media which change volume with water content change owes much to the insights of John Philip. In particular, his development and explanation of a one-dimensional model in Eulerian space which correctly accounts for the statics and dynamics of the phases in a two-phase swelling system remains an outstanding example of the combination of the methods of mathematics to clear physical insights. In addition, transformation of the model to Lagrangian space permits use, for swelling systems, of all the methods of analysis developed in soil physics to describe water flow in non-swelling soils. The approach has been used to describe important practical problems involving colloidal and soil systems in chemical and civil engineering. Regrettably, there remain substantial difficulties which prejudice its use in agriculture. This review discusses some of these issues and comments on further areas for study.

DE Smiles, 61 62 465 937

Energy Relations of Propagating Cracks in Varibly Plastic Soil. V.A. SNYDER* and M.A. Vazquez, Univ. of Puerto Rico.

A critical condition for crack propagation in a soil is that the strain energy released by the material as a crack propagates must be greater than the surface tension energy associated with formation of new crack surface area. This principle is of great relevance to processes of fragmentaion during tillage. However until recently, fracture parameters could only be measured in elastic or "near elastic" materials, which severely limited the study of plastic materials such as moist soil. Recent advances have now extended fracture mechanics theory to the fully plastic regime. These advances and resulting experimental implications for the study of soil fracture are discussed.

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Simple Baluns in Parallel Probes for Time Domain Reflectometry. E.J.A. SPAANS* and J.M. BAKER, Univ. of Minnesota and USDA-ARS, St. Paul, MN.

Time domain reflectometry (TDR) is used for the simultaneous measurement of soil moisture content and electrical conductivity (EC). Limitations of parallel probes compared to coaxial probes have been signal losses in the antenna wire leading to the probes, and the need for an expensive balun. In addition, signal attenuation in the balun hampered accurate EC determination. In this poster a balun is described which avoids these limitations. The balun is inexpensive and easy to fabricate, and is attached directly to the waveguides. This permits a system with coaxial transmission lines from the TDR to the parallel waveguides. The performance of this new balun for soil moisture content determination and EC is discussed and compared to a conventional balun.

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Advising M.S. Graduate Students: Issues and Perspectives. D.L. SPARKS, Univ. of Delaware.

One of the most important, satisfying and challenging aspects of an academic position is the advisement of graduate students. A very important part of graduate studies is the training of M.S. students, the primary focus of this paper. The paper will include discussions on the following: advisor-advisee relationships, differences in advising M.S. and Ph.D. students, the role of the major professor in developing and directing the student's research program, development of a course of study and research project; and, the importance of interactions with faculty, other graduate students and postdoctoral associates.

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Accurate knowledge of the transport of chemicals through the unsaturated soil is, in large part, limited by the accuracy of available sampling techniques. Multivick and zero pan samplers, consisting of a 5x5 cm grid of individually sampled 3 cm square compartments, were tested. Samplers were installed in horizontally excavated tunnels at a depth of 60 cm. In addition, for comparative purposes, suction cup samplers and wells were installed. The performance of the samplers was evaluated for a well-drained crack network. For the silt loam soil, the wick and zero pan samplers and a formed gravity pan sampler and suction cup samplers at the same depth. Suction cup samplers missed the initial high flush of solutes completely.

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Advances in industrial computed tomography (CT) now offer powerful tools for scales not attainable with medical CT. Industrial high-resolution CT scanners can image soil samples on the order of 25 mm in diameter with resolution of 25 µm while high-energy (2.5 MeV) CT scanners can achieve 1 mm resolution on samples up to 1 m in diameter. This paper presents CT images of