ADVECTIVE TRANSPORT IN POROUS MEDIA: Analytical, Computational and Experimental Approaches

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The transport of chemicals and other contaminants in porous geological media is a topic of fundamental importance in the general area of geosciences and of particular interest to geo-environmental engineering. The basic mechanisms of transport range from advective transport, which depends on an advective flow velocity, to diffusive transport that depends on a concentration gradient. Although the fundamental processes governing these basic modes of transport can be highly non-linear and dependent on the micro-structural morphology and chemistry of the contaminant and the porous medium, the linear theories associated with these basic transport processes provide useful first approximations for the study of both advective and diffusive processes. The advective process in particular provides estimates for the time and spatial distribution of the chemical species in the porous medium which constitutes an important input to the environmental decision making process. The methodologies available for the solution of the classical advective transport equation has evolved over the past three decades and these approaches can vary from purely analytical techniques to several computational schemes that tend to minimize numerical errors associated with the solution procedure. This lecture will focus on the calibration of the advective transport equation associated with time-dependent advective velocities. The time-dependency in the advective velocities can be a result of time-dependent variations in the boundary flux associated with the potential problem. The calibration of the computational procedure for the linear advective transport with time-dependent velocities is facilitated through recently developed analytical solutions for multi-dimensional advective transport problems. The robustness of the numerical schemes are particularly challenged when the chemical migration profiles have a *discontinuous front* and the advantages of diffusive phenomena are not available to mitigate processes such as overshoot and negative values in the chemical concentration profile. The lecture presents the overall calibration of the computational approaches with analytical results and uses the methodologies to examine the advective transport in a one-dimensional experimental configuration involving time-dependent advective flow velocities.

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