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Transport in groundwater flow - researches on characterization of solute transport in relation with aquifer structure and flow conditions

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ABSTRACT - Whatever the transport characteristics we use, the hydrodispersive parameters such as dispersivity, kinematic porosity or impulse response are linked to physical media (reservoir geometry and stucture) and, on the other hand, to flow conditions which can vary in time, whether they are natural (effect of rainfall) or artificial (pumping effect). On various scales of void (microscopic porous, fissured and dual-porosity, rather open fractured, karstic media) we have attempted to properly separate these two kinds of influence. In order to point out preferential directions and velocities of flow, on a regional or local scale, in fractured media, the study methods of mass transport are much more sensitive than hydrodynamics and enable us a rather accurate analysis of the relationships between structure and flow. The relationships between geometry and flow have been analysed on the laboratory scale and even on microscopic scale. The variability of the so-called intrinsic parameters (linked to the reservoir) with regard to the scale, seems to express the fractal character of the dispersion and diffusion transports, when the particles are actually following more and more tortuous pathlines while the straight line distance is increasing.

INTRODUCTION

Many kinds of models have been conceived to reproduce the groundwater convective transport in aquifer as in fracture network or in karstic system. Some need conceptual assumptions or knowledge of the underground system : successive compartments where each has its own part, superposed (convective, dispersive) flows and immobile phase exchanges. Without conceptual apriorism, some others hold the system as a "black box" of which the main part is transforming an input signal into an output signal. At last, some others are stochastic, built upon the random travel of a lot of particles. In our Laboratory, we have chiefly focused our researches on :

- Three sorts of media : the porous ones, homogeous or not, with or without molecular diffusion in rock matrix, the fractured and the karstic media.
- A deterministic conception of media, to show off the part of geometry and structure, by trying to separate the effects of variable flow states (velocity, discharge, injection conditions) from it.
- Hence, thoughts about the meaning of dispersivity and the part of the diffusion into rock matrix. The fractal geometry can help to understand why and how "intrinsic" parameters can vary.
- System analysis in karstic media, by conceiving and realizing a transformation method of impulse responses when discharge varies, as it usually occurs in karstic systems.

1 - POROUS OR FINELY FISSURED MEDIA

The Chalk is the main regional aquifer in the northern half of France. It is a double-porosity medium (large porosity of matrix, often more than 40%, and gravity flow only by fissures where the porosity is rather low, a few percents). The

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