**BOOK REVIEW**

*Subsurface fluid flow and imaging*

*With applications for hydrology, reservoir engineering and geophysics*

by D.W. Vasaco and A. Datta-Gupta

**by A.Dassargues**

Nowadays the word ‘imaging’ is definitely more trendy than the words ‘characterization’ and ‘modelling’. But clearly the importance of imaging in Earth Sciences is far beyond a matter of fashion. It is clearly needed to help understanding the actual heterogeneity despite the lack of direct images of the underground. This book introducing methodologies for subsurface imaging shows the transversality of the used mathematical techniques and the similarities that can be drawn from the various applications presented. Many techniques in groundwater modelling, applied geophysics and reservoir engineering are using inverse modelling procedures where observations are used to infer and constrain properties values. The modelling techniques tend to show final results under the form of images like, for example, solute transport tomography, time-lapse geophysical results, or deformation and strain fields.

After a short, but nicely exposed chapter, on equations of (multi) fluid flows and coupled transport and deformations, the authors are describing asymptotic and trajectory-based methods for modelling these processes in the underground. Treating general first order partial differential equations, it leads to the method of characteristics and to the wave equation. The authors show that the asymptotic method is particularly adequate for partial differential equations with spatially varying coefficients, as those describing the heterogeneous properties of any underground medium. Trajectory-based modelling are then applied to second order partial differential equations (diffusion form) with a high frequency asymptotic solution. It allows, under a common framework, a conceptual partitioning between travel time and amplitude computations. For equations governing advection and dispersion transport, the authors proposed an asymptotic formulation of a solution leading to a trajectory-based approach that can be used backward and forward. The same kind of approach is applied to immiscible fluid flows and coupled (elastic) deformation and fluid flow in porous media.

The presentation is really innovative and allows to get a unified view on the modelling of different physical processes from wave-like hyperbolic problems, to diffusive parabolic problems and non-linear coupled problems of mixed character. The exposed imaging techniques present the advantage of being well adapted for further determining accuracy and spatial resolution of the simulated results. The book is well written, many clear figures are used, but the colour figures are unfortunately localized only in the book centre. The references and index lists are very useful for the interested reader.

I am afraid that the book content would be slightly too mathematically evolved for most undergraduate students (except maybe for the more skilled among them in applied mathematics) but I am sure of its large utility for academic researchers and industry practitioners in the fields of geoscience, especially in hydrogeology, oil reservoir and environmental engineering. The online software applications and examples will help enabling readers to gain hands-on experience.