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'Bible' of the Hydrological Sciences Celebrates its 30th Year

Jacob Bear's *Dynamics of Fluids in Porous Media*, first published by Elsevier in 1972 and re-issued by Dover in 1988 as a classic in its physics and chemistry series, has reached the age of 30. And yet, the suffix "years old" is not applicable to the book, as it continues to be heavily referenced to this day by both academics and consultants.

In the 1960s, Jacob Bear displayed remarkable foresight by recognizing the need for a volume that would present a comprehensive, interdisciplinary approach to understanding and quantifying phenomena of flow and transport of solutes in porous media, as encountered in groundwater hydrology, in petroleum reservoir engineering, in soil physics, in agricultural engineering, and in chemical engineering. He produced a book that addressed all of these fields, and which was written in a unified language that considered the underlying principles of flow in porous media at a level and on a scale not previously attempted.

Upon publication, the book quickly became the "bible" on flow and transport in porous media. As Bear stated in his preface, this effort represented the first "single framework" approach to quantifying transport in porous media. Interestingly, while now taken for granted, the word "transport" had not yet been "invented" for use in this context, and researchers tended to speak of "flow" and of the movement of dissolved matter. Thus, one of Bear's main objectives in writing the book was to demonstrate how the phenomena of transport in porous media could be unified into a single discipline. He chose to do this by emphasizing physical phenomena and how to describe them through well-posed mathematical models.

The book included both saturated flow and unsaturated flow, as well as two-phase immiscible flows. To appreciate the unusual nature of the endeavor, one must know that at the time, saturated flow was handled by hydrologists, unsaturated flow by agricultural engineers, and two-phase flow by petroleum reservoir engineers; solute transport with adsorption, for example, was the territory of chemical engineers. As another historical point, it is worth observing that the chapter on hydrodynamic dispersion, which deals with solute movement, or "miscible displacement," as it was referred to then, was perhaps the first to consistently use the term "transport in porous media." In fact, in 1967, Bear established the section on transport in porous media in the International Association for Hydraulic Research, and was its chairman for 4 years. Of course, these ideas and terminologies are now conventional wisdom, and no enlightened researcher or educator would dream of working or teaching in the earlier, more parochial frameworks!

True, some of the material in the book is less relevant in today's world, but then even some aspects of the history of hydrology, such as the use of electric analogs for aquifer regimes and Hele-Shaw models for seawater intrusion, make for fascinating background reading.

There is no question that *Dynamics of Fluids in Porous Media* has left a lasting mark on the geophysical community, affecting the education and work of more than a generation of hydrologists; soil physicists; and petroleum, chemical, and agricultural engineers. To attest to its truly international nature, and in both China and Japan, the book is "the" standard text. Because the book deals with fundamentals, it is still valid today, and indeed, it continues to be quoted often.

The contribution of this book is well-summarized in a book review by R. Allan Freeze, published in *Geotimes* in 1973, which concluded with the words, "I envy the students who will step out of their graduation gowns with such a course in hand. Perhaps soon we will be able to claim that the quantitative revolution has reached maturity in at least one of the earth sciences." [*Geotimes 18, 4*, pp. 35–36, 1973]. It seems that this prediction has become a reality: this book has indeed been instrumental in helping to mature hydrogeology into a quantitative science over the last 30 years.

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