



Upscaling of Darcy's Law in Media with Variable Porosity: A Re-Examination

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The upscaling of Darcy's Law is frequently advocated to escape from the core scale and develop laws for water flow in porous media at more relevant scales. Considerable effort has been dedicated to developing proper upscaling procedures. Recently, upscaling to the meter scale stirred debate because the presence of a well-defined heterogeneity created an inconsistency between the core-scale and the meter-scale version of Darcy's Law. This inconsistency was resolved by adding a correction term to the upscaled version (Gray and Miller, *Environ. Sci. Technol.* 2004, 5895-5901). This contribution reports the result of a re-examination of the well-posed heterogeneity problem, and shows that a consistent, physically rigorous treatment of the various components of the hydraulic potential eliminates the need for the mathematical correction, facilitating the desired upscaling in case of poorly defined heterogeneities. The analysis offers some new insights in the physical meaning, or lack of such meaning, of upscaled variables depending on the nature of the variable, and the dimensionality and orientation of the upscaling operation.