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Upscaling of mass transfer in field-scale discrete fracture networks using fractional-derivative models

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Mass transfer in field-scale discrete fracture networks (DFNs) is affected by the erratic internal structure and hydrogeological properties of the fractured media, which can result in non-Darcian flow due to channeling flow and non-Fickian transport due to matrix diffusion competing with fast displacement along fractures. This study explores flow and transport dynamics in various DFNs with a wide range of physical properties using the Monte Carlo simulation approach. The resultant mass transfer dynamics are then quantified by fractional-order derivative models built upon the promising fractional calculus. We will report results implying information transfer from non-Darcian flow to non-Fickian transport, and we will also try to explore the quantitative linkage between these two related processes. The goal is to develop efficient upscaling approaches using the spatiotemporally non-local fractional-derivative equations to characterize mass transfer in field-scale fractured media, without the need to map individual rock fractures.

References

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