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Multi-scale dynamics of colloidal deposition and erosion in porous media NAVID BIZMARK, Princeton Institute for the Science and Technology of Materials, Princeton University, Princeton, NJ 08544 USA, JOANNA SCHNEIDER, RODNEY PRIESTLEY, SUJIT DATTA, Department of Chemical and Biological Engineering, Princeton University, Princeton, NJ 08544 USA — Diverse processes—e.g., environmental pollution, groundwater remediation, oil recovery, filtration, and drug delivery—involve the transport and deposition of colloidal particles in three-dimensional porous media. Using confocal microscopy, we directly visualize this process in situ and thereby identify the fundamental mechanisms by which particles are distributed throughout the pore space. At high injection pressures, hydrodynamic stresses cause particles to both deposit on and become eroded from the solid matrix continually— strikingly, forcing them to be distributed throughout the entire medium. By contrast, at low injection pressures, the relative influence of erosion is suppressed, causing particles to be localized near the inlet of the medium. Unexpectedly, these macroscopic distribution behaviors are tuned by imposed pressure in similar ways for particles of different charges, even though the pore-scale distribution of deposited particles is sensitive to particle charge. Our results thus reveal how the multi-scale interactions between fluid, particles, and the solid matrix control how colloids are distributed in a porous medium.

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