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# Mechanism of anomalous straining of colloidal size particles in porous media

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## Abstract:

The classical retention theories consider filtration as the mechanism responsible for the retention of colloidal size particles, and grain surfaces as the locations where retention occurs. Several independent studies observed the retention of particles much smaller than the smallest pore throat under conditions that minimize retention by attachment/detachment. However, until now no mechanism for this anomaly has been proposed. Investigators concluded that straining must have contributed to retention. The objective of this work is to determine whether straining in small gaps between pairs of grains can account for the observed retention.

A geometric and statistical analysis of model sediments (computer generated) revealed that the number density of gaps is large enough to trap a considerable number of colloidal sized particles. We hypothesize that in a given gap the rate of retention, and therefore the rate constant for straining, is proportional to the flow that passes through the gap in order to trap a colloid. Detailed flow distributions within throats, within gaps, and near the point contacts were computed to test this hypothesis. We also hypothesize that there is a nonzero probability of colloid escape, even if it enters the gap. The possibility of collision and rebound of colloids when approaching constrictions was considered by assuming that the probability of trapping is correlated with the angle of incidence of the colloids and with the average flow velocity. This model confirmed a reported empirical relationship between the straining rate constant and the ratio of colloid to grain size, thereby identifying the mechanism behind the anomalous observations of straining.

## Impact Statement:

This project describes a model that explains the mechanism behind a long-standing anomaly observed in the retention of colloidal size particles. The model fits several empirical correlations between straining rate and particle size showed in the literature.

The ideal sediments (computer generated packings of spheres) used in this model have proven to be a helpful tool when studying phenomena that depend on the geometry of the pore space.

Category: Other Water Resource Topics
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