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How well can we determine the permeability of clastic sediments?

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Permeability data is almost exclusively confined to shallow aquifers and deeper geothermal or hydrocarbon reservoirs. As a result predicting permeability and fluid flow on the scale of sedimentary basins is fraught with uncertainty. Here we explore how well existing and new equations can predict the permeability of clastic sediments using data on porosity, clay content and grain size distribution. We keep things relatively simple by focusing on sediments that have never been buried deeper than 2 km and have not experienced significant burial diagenesis. We first use a compilation of published data to evaluate equations for the permeability of pure granular material and clays. Secondly, we use newly compiled permeability data of natural sediments with varying clay content to explore how the permeability of sand and clay mixtures relates to the permeability of the pure sand and clay components. The permeability of natural sediments shows markedly different behavior than experimental binary mixtures on which several permeability algorithms are based. We find that permeability is best predicted as the geometric mean of the permeability of the sand and clay components. Permeability can be predicted with a mean error of 0.6 order magnitude if the grain size distribution is known. We also show that permeability can still be estimated with an error of 0.7 orders of magnitude using only clay content and porosity data derived from neutron and density logs. This raises the prospect of characterizing sediment permeability at much larger scales than the intervals for which samples or pumping tests happen to be available.