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Representative Elementary Volume Analysis of Sand Using X-ray Computed Tomography

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The concept of representative elementary volume (REV) is critical to understand and predict the behavior of effective properties of complex heterogeneous materials (e.g., soils) at different scales. In quantitative terms, REV is typically dependent on the scale of observation, referring to the size of the objects to be investigated and the degree of precision required for the computation of effective physical and mechanical properties. It is assumed that the continuum of a given heterogeneous material can be represented by a discrete REV without significant changes observed of the physical properties.

In this study, 3-D volumes of natural sand packed at five different particle fragments were obtained using X-ray Computed Tomography (CT) to provide a systematic quantification of the size of REVs of different physical properties. These properties include global and local porosities, sphericity, angularity, specific surface area, coordination number and network of contacts. A systematic method is used to compute the size of REV of each property in terms of d50 of the system. REV analysis includes application of efficient and robust image processing algorithms to calculate the underlying properties from large 3-D data sets. REV sizes of different properties are computed to verify the accuracy of the typical use of porosity as a base to calculate REV for heterogeneous porous media systems.