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Scale-independent rock heterogeneity classifier applied to microtomography images

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Typical geological systems are composed of a broad spectrum of porous media with regionalized rock properties such as porosity or permeability varying by orders of magnitude within a volume of study. Upscaling the petrophysical rock properties is controlled by the rock pore size and type heterogeneity which is a scale-dependent variable. At the same time, Recent advances in high-resolution imaging techniques have provided a wealth of 2D and 3D datasets that reveal the microstructure of rocks and soil on scales ranging from nanometers to centimeters. However, the images by themselves greatly vary based on imaging technique details and objectives of research taken in porous media. Automating the rock heterogeneity estimation regardless of the type of imaged input would be of great interest to geology and engineering communities.

We provide an automatic scale-independent method for classifying rock heterogeneity. Our method modifies local order metrics by (Torquato et al. 2022). They used synthetic, two-phase porous materials and compared relative ranking of disorder for materials with the same length scale and porosity. Our modification introduces length scale independence and was verified against three categories of benchmarks, all together 87 geologic and synthetic 3D CT datasets found in Digital Rocks Portal (https://www.digitalrocksportal.org/). Further, the method performs better compared to other geostatistical heterogeneity coefficients including Dykstra-Parsons, Lorenz, and pore heterogeneity coefficients. A sensitivity analysis has revealed a significantly faster performance and reliable true heterogeneity of the 3D version compared to the apparent heterogeneity seen when splitting 3D volume in its 2D cross-section. Thus, whenever possible, 3D datasets should be used in analysis of porous media. While our application is to the images in Digital Rocks Portal and we hope that will in future ease automated curation of images in the portal, the method should extend easily on any porous media imagery.

Participation

In-Person

References

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