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A fast hybrid method of reconstructing 3D digital rock

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3D digital rock is widely used in the oil and gas industry to analyze pore structures and estimate petrophysical properties of rocks, such as permeability, elastic modulus, resistivity, and nuclear magnetic resonance response. Computed tomography (CT) images are the most common data for constructing 3D digital rock. However, the CT experiment is expensive, and rocks are not easy to obtain in some cases. It is still necessary to study the method of reconstructing 3D digital rock from one 2D slice.

In the presented work, we put forward a fast hybrid method of reconstructing 3D digital rock and investigated its effectiveness. We first reconstructed 3D digital rock (S1) with 200×200×200 voxels by the traditional sequential indicator simulation method (SISIM) from one 2D CT slice. Corrosion and expansion operations were then applied on the reconstructed 3D pore spaces to generate the new 3D digital rock. We determined whether the absolute error between the porosity of the newly generated digital rock and the actual porosity was less than 0.5%. If not, the corrosion and expansion were repeated until the absolute error was less than 0.5%, and then the final 3D digital rock was reconstructed (S2). Permeability, resistivity, and local porosity distribution function of the reconstructed digital rock were also calculated to verify the validity of the new method.

Results show that the 3D digital rock constructed by the hybrid method has good long-distance pore connectivity characteristics. Compared with the permeability of S1 (126.94 mD), the permeability of S2 is increased by at least seven times (889.19 mD), which is in better agreement with the actual result (970.73 mD). The saturation indexes of the digital rock models S1, S2 calculated by finite element method are 1.99 and1.73, respectively. The actual saturation index is 1.64, which verifies the accuracy of the new method. The geometric mean of the local porosity distribution function of S2 (0.19 %) agrees well with the actual result (0.18 %), which also shows the reliability of the new method. It takes less than 3 minutes to generate a digital rock by using the new method, which is faster compared to the multiple-point statistics method and artificial intelligence methods.

The proposed methodology is simple and fast, which has the potential to attract more researchers to use it. Moreover, this hybrid method will be helpful in gaining insight into the relations between the pore structures and petrophysical properties by analyzing a large number of stochastic reconstructed digital rocks.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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