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Three-dimensional imaging of pore-fracture propagation in Triassic tight sandstones of the Ordos Basin, Northern China

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The characteristics of fracture propagation in heterogeneous tight sandstones are critical to volumetric fracturing, which is the key to unlocking unconventional resources in tight sandstones. Quantification of the influence of pre-existing pore systems and particle arrangements on the propagation of fractures is challenging due to inadequate imaging of the internal void systems in tight sandstones from three-dimensional (3D) aspect. In this study, the 3D geometry of tight sandstones from the Upper Triassic Chang 7 member in the Ordos Basin is continuously imaged under different loading stresses, and the voxel resolution of the X-ray computed tomography is 2.5 microns. The data set captured in this process shows the changes in the samples at the microstructural level as they approach fracturing. The data are stored as a time series of 3-D images. The results demonstrate that: (i) fractures propagate progressively and gradually link with pre-existing pores, resulting in macroscopic fractures with a maximum width of 250 microns, while newly generated fractures could break up particles and may not follow the line of pre-existing fractures; and (ii) three stages were identified in the failure process of tight sandstones, with new fractures running at an angle of about 30° to the general direction of the stress of compression. The total volumes of both the sample and pore-fractures, and the damage index, which were extracted from the 3D images, all increased when approaching fracturing. The final volume of pore-fracture systems could be 11 times that of the initial pore volume. All of these observations provide valuable insights and design guidelines for hydraulic fracturing in unconventional tight sandstones, and a quantified model of the dynamics and the morphology of fracture propagation with increasing stress approaching failure, which may shed light on dynamic critical transitions in the Earth's crust.

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References

Time Block Preference

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

Participation

Online

Primary author: WU, Songtao

Co-authors: Dr YU, Zhichao; Ms JIANG, Xiaohua; Mrs SU, Ling; Dr TIAN, Hua; Dr LIAO, Fengrong; Dr YU, Cong

Presenter: WU, Songtao

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