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Application of 2D and 3D imaging technology in the observation of porous media containing natural gas hydrates

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Natural gas hydrate is a potential new type of energy, mainly found in sediments in marine or terrestrial permafrost regions. The content, distribution, and growth or decomposition of natural gas hydrates in sediment pores or fractures, greatly affect the physical properties of the medium. This study mainly introduces the experimental techniques and methods for micro and nano scale imaging of porous media containing natural gas hydrates based on Micro-CT and Cryo-SEM. In response to the observation needs of natural gas hydrates at low temperature or high pressure, a dedicated auxiliary observation container has been independently developed, which can observe the microscopic morphological changes of hydrate growth and decomposition processes. At the same time, a non-destructive transfer device suitable for CT and SEM scanning was also designed, aimed at conducting CT and SEM imaging observations on the same sample, achieving joint observation of CT images and SEM images. In addition, a fusion method for micrometer and nanoscale digital core images has been developed, which utilizes self supervised learning algorithms in machine learning to achieve a 2x and 4x increase in spatial resolution of CT images.

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