Change in reservoir structure of different lithotypes of lignite with dehydration

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Find out the changes in lignite properties accompanying dehydration will not only benefit the development of lignite CBM, but also play a guiding role in the underground gasification, combustion, coal cleaning, and carbon dioxide sequestration. Especially for the utilization of lignite coalbed methane resources, the dehydration can greatly improve the gas flow capacity in lignite reservoir with originally low permeability. Through nuclear magnetic resonance (NMR) tests, imaging experiments, and permeability tests, the changes of reservoir properties of different lithotypes of lignite during dehydration were comprehensively summarized. Additionally, a bituminous coal sample was also tested as a supplement to better understand the impact of coal rank on changes in reservoir structure after dehydration. Drying and dehydration will cause the coal matrix to shrink, and NMR results show that its effect on the structure of the lignite reservoir is shown in two aspects: the rapid expansion of large fractures, and the shrinkage of relatively small pores. Due to the influence of material composition and molecular structure, the change of the reservoir structure of bituminous coal after dehydration was not as obvious as that of lignite. Overall, dehydration improves both total porosity and connected porosity. However, due to the shrinkage of the matrix, the pore connectivity may deteriorate. As a paramagnetic material, Mn$^{2+}$ dissolved in water shorten the transverse relaxation time of the $^1$H by dipole-dipole interaction (dipolar coupling) between the electronic magnetic moment of the ion and the nuclear magnetic moment of the hydrogen proton. As Mn$^{2+}$ enters the connected pores, the signal of the water in these pores is dampened and becomes invisible. It is clear that the disappeared portion on the T$_2$ spectrum represents the connected pores into which Mn$^{2+}$ can enter. By combining the NMR experiment with Mncl$_2$ imbibition, it was found that the connectivity of some of the micromesopores was worsened: the disconnected porosity of the matrix lignite and xylite lignite after 12 hours of drying increased from 0.32% and 0.08% to 1.19% and 1.82%. NMR imaging and X-ray computed tomography imaging results show different fracture propagation rules of different types of lignite during drying. Matrix lignite can quickly generate evenly distributed fractures with drying, but these fractures are short in length and poor in orientation; xylite lignite has a lower dehydration efficiency, and the fractures generated follow a pattern that gradually expands from the surface to the interior, but can eventually form a long and well-oriented fracture network. The results of permeability tests show that dehydration greatly improves the permeability of lignite reservoirs. Since coal permeability is highly stress-sensitive, the effect of stress on the permeability of these samples before and after dehydration was further analyzed. Although the effect of stress on permeability after drying has increased, the effective permeability after drying is always orders
of magnitude higher than before drying. In sum, dehydration is an effective measure to improve the seepage capacity of lignite reservoirs, which provides a basis for the efficient development of lignite CBM and the clean use of lignite resources in other ways.