Scientists characterize shale cap rocks at tiny scales

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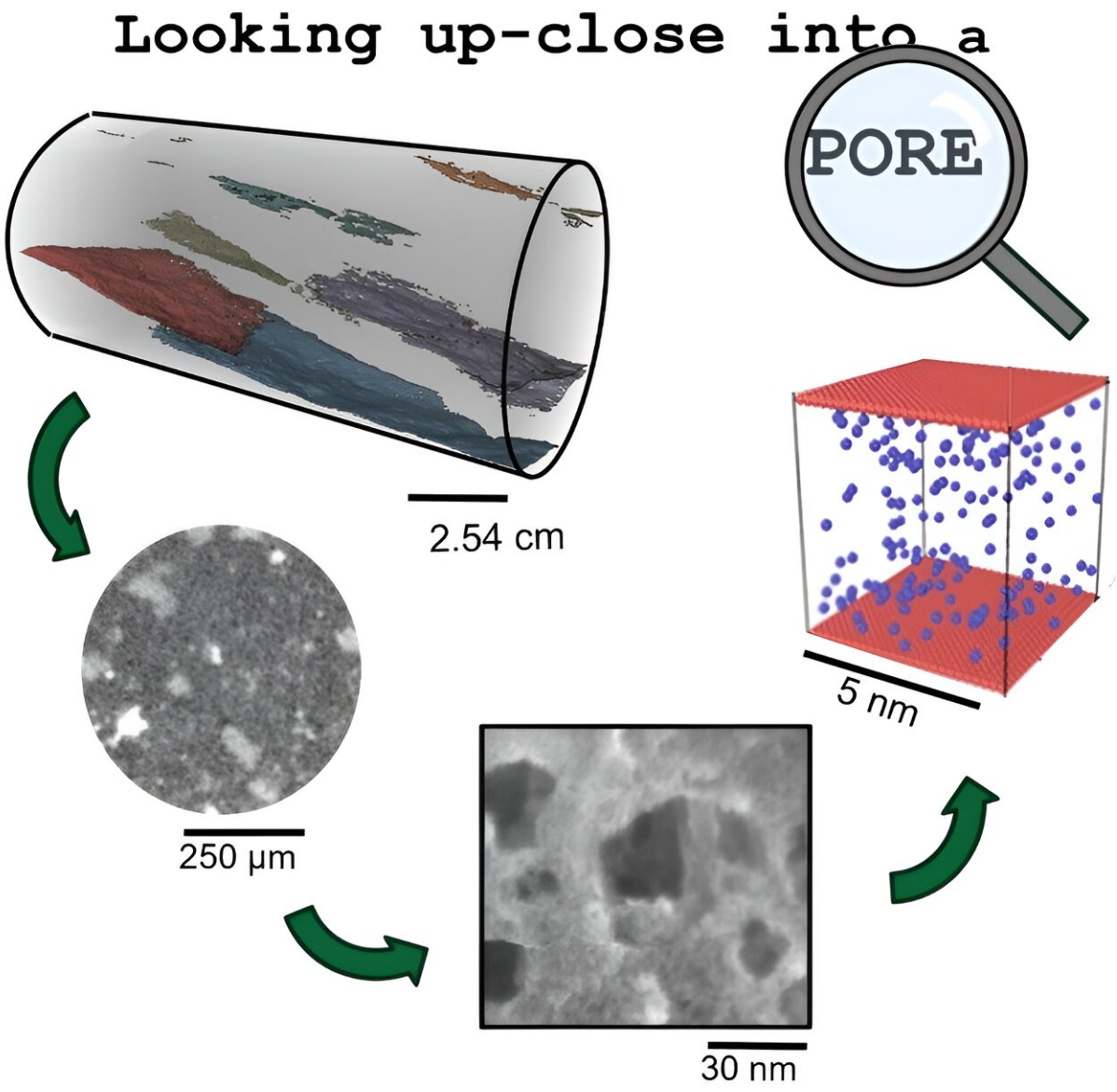

Shale is physically and chemically complex at all scales of interest. Multimodal, multiscale imaging, and characterization allows researchers to study how to control the transport and reactivity of matter inside complex porous structures such as shale. Credit: CMC-UF

A team of researchers is working on a multidisciplinary approach to advancing the exploration of shale rock as a suitable geological seal for resource recovery and underground storage. Given that the pore space in shale rock is predominantly sub-micron, these studies focus on the micro and the nanoscale.

The group's work includes developing electron tomography capabilities for shale imaging, simulating methane adsorption and transport in shale, studying the effects of supercritical carbon dioxide on shale pore structures, and other related areas.

The most recent published results, which appear in *Physics of Fluids*, involve simulating how methane flows through channels in shale at the nanoscale, and experimental work on how coupled mechanical and chemical processes serve to improve the sealing properties of shale.

Shale is a sedimentary rock made up of tiny grains of silica, clay and other minerals. Many types of rock have few physical or chemical differences in a particular chunk of that rock. Shale is different—it has a huge mix of physical and chemical features. These features include tiny nano-sized pores that connect to millimeter-scale fractures.

This variation in scales affects how fluid moves through shale. Fluids move through these pores and fractures in unusual ways that are very difficult to measure and to model with traditional analytical and numerical tools. Researchers are now building new tools to examine,

characterize, and simulate chemical and physical processes in shale. They are particularly interested in shale cap rock—layers of rock that are quite resistant to transport through them, making cap rock ideal for storing fluids in the layers of underlying rock that they seal.

Scientists need a comprehensive understanding of how fluid moves through shale because this material has many potential roles in national economic security and the future of our environment. Shale has become an important source of natural gas and oil for U.S. consumers and industry, reducing dependence on foreign supplies. Shale is also the caprock or seal that prevents upward migration of carbon dioxide that has been captured at large emission sites or removed from the atmosphere and stored in the subsurface.

This technology has a potential role in broader efforts to combat climate change. Shale may also be able to store hydrogen and other alternative fuels, helping make these fuels a viable alternative to petroleum. New tools and data are providing the information scientists need to understand how shale works in these and other applications.

More information: Lingfu Liu et al, Scale translation yields insights into gas adsorption under nanoconfinement, *Physics of Fluids* (2024). DOI: 10.1063/5.0212423

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