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New approach to evaluate breakthrough pressure using MICP

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Geological carbon sequestration, the capture and underground storage of CO2, is widely considered the primary approach to offset CO2 emissions from large-scale fossil fuel consumption. A key requirement for any potential storage site is the presence of an effective caprock. The caprock's sealing capacity, or its ability to prevent CO2 escape, is critical in any proposed storage project [1]. One of the most important properties to evaluate the caprock's sealing capacity is the breakthrough pressure (also known as threshold pressure). It can be defined as the pressure in the nonwetting phase necessary to displace the wetting phase in a way that a continuous flow is established [2]. Due to their simplicity, quickness and low cost, Mercury Intrusion Capillary Pressure (MICP) is commonly used to measure breakthrough pressure. This method uses high pressure to force mercury (nonwetting fluid) into the sample pores. The Washburn equation relates pressure and pore size [3]. Typical MICP results are shown by plotting the accumulated volume of intrude mercury against the injection pressure. These values are converted from the mercury–air–rock system to other systems of interest, for example, the CO2 –brine –rock system, considering the contact angle and interfacial tension. The breakthrough pressure may be determined by analyzing changes in the curvature of this curve [4], but often, this pressure is not clearly defined: the mercury appears to gradually penetrate the pore system without an evident critical pressure, indicating the abrupt formation of a percolating cluster. To overcome this difficulty, a new procedure in the mercury intrusion experiment, before the MICP curve analysis, is proposed to identify the breakthrough pressure. This method consists of the insertion of a relatively big artificial pore after a layer of the sample. This way, a pronounced intrusion is recorded when the mercury percolates the sample and reaches the artificial pore. So far, the results show that this approach is promising, with some experimental hurdles still to be overcome.

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