https://www.micromeritics.com/product-showcase/Shale-Characterization.aspx

Shale Characterization

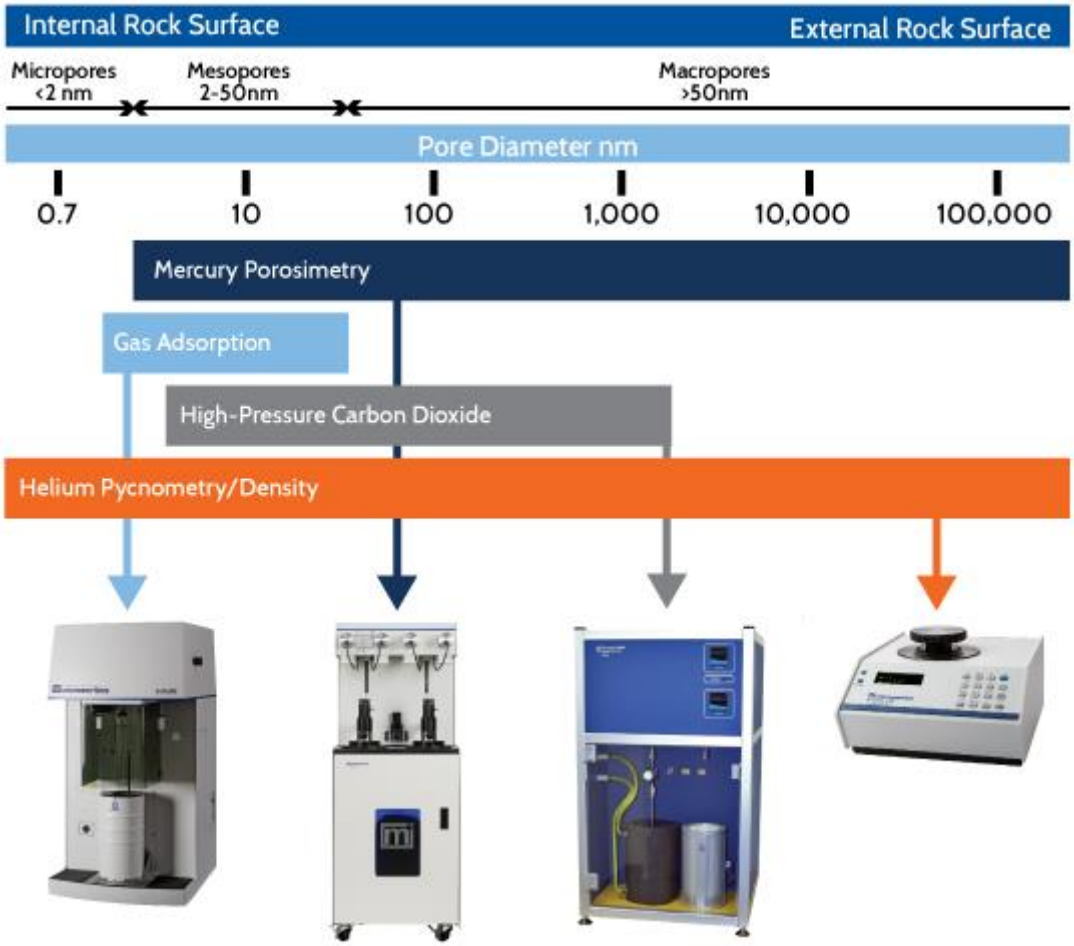
Materials Characterization Solutions to Determine Unconventional Gas Reservoir Potential

Shales are complex reservoirs and present significant challenges to petrophysical characterization and physical core analysis. Key reservoir parameters for shale deposits include: thermal maturity, reservoir thickness, total organic carbon (TOC) content, adsorbed gas fraction, free gas fraction within the pores and fractures, and transport properties.
Thermal maturity and reservoir thickness are routinely measured. The remaining four parameters require a creative approach that can utilize a number of petrophysical rock core measurement techniques.

Micromeritics provides key analytical tools for evaluating rock cores and shale reservoir potential.

- Reservoir performance evaluation
- Gas storage capacity of shale and kerogen
- Correlation between geological conditions and physical properties
- Organic and non-organic matrix porosities and pore distributions

Micromeritics also provides computational and modeling tools for modeling and predicting shale reservoir potential.



Rock Storage Properties

It is of vital importance to determine a reservoir's capacity for adsorption of hydrocarbon gas. Pore volume provides a measurement of the capacity of organic and non-organic components of the shale to store gas. Through the application of sub-critical nitrogen or carbon dioxide gas adsorption, the acquired analytical data will indicate capacity as well as reveal information about pore volume, area, and pore distribution.

Gas adsorption analysis by sub-critical gas adsorption is used to characterize core samples to determine:

- Free gas stored within pores
- Adsorbed gas on the surface and within the organic matter
- Dissolved gas in pore fluids
- Mesoporosity, microporosity, and total pore volume character
- Desorption kinetics for estimating the rate of gas production

Micromeritics' 3Flex Surface Characterization Analyzer is a fully automated, three-station instrument capable of high-throughput surface area, mesopore, and micropore analyses.

Included Data Reduction Models

Surface Area	Pore Volume	Pore Size
BET	BJH	NLDFT
Langmuir	t-Plot (micropore volume)	HK
BJH	BJH (meso and small macropore volume)	BJH
t-Plot	MP	Dubinin-Astakhov
	Dubinin-Astakhov (micropore volume)	

Methane Capacity of Shale

Methane Capacity of Shale at Specific Pressure and Temperature

Many shale gas formations are over pressured. Super critical gas-adsorption parameters are needed to estimate total amount of gas in the system. Measuring the shale capacity for adsorption of hydrogen gas at pressures and temperatures that may exist at depths is important to the evalutaion of a reservoir.

High-pressure methane can be dosed onto shale sample to generate adsorption and desorption isotherms. This provides the methane capacity of the shale at specific pressures and temperatures.

The adsorption isotherm can be used to calculate the Langmuir surface area and volume of the shale. The Langmuir volume is the uptake of methane at infinite pressure - the maximum possible volume of methane that can be adsorbed to the surface of the sample.

- Determine Langmuir surface arfea at simulated shale depth conditions
- Provide kinetic data to show the rate of adsorption and desorption

The HPVA II Series of gas adsorption instruments uses the static volume method to obtain high-pressure adsorption and desorption isotherms.

Mercury Intrusion Porosimetry

Shale Pore Throat Size, Pore Volume, and Pore Size Distribution

Mercury intrusion porosimetry is a valuable method for characterizing relative pore space dimensions. Mercury intrusion porosimetry permits the calculation of numerous sample properties such as pore size distributions, total pore volume, total pore surface area, median pore throat diameter, and sample densities (bulk and skeletal).

Capillary behavior and permeability are critical to reservoir behavior. This method is particularly useful in evaluation reservoir quality variations within a shale play and in petrotyping shale. While not quantitative, these estimates can provide a relative assessment of the variation in permeability.

Mercury intrusion, used in conjunction with pycnometer data, provides estimates of the fraction of pore space that is connected and as such producible. Mercury intrusion also provides information in terms of tortuosity, or the loss of interconnectivity of micro channels under depth conditions, that will lower permeability, as well as gas and water flowability.

The AutoPore V Series uses mercury intrusion and extrusion to determine total pore volume, pore size distribution, percent porosity, density, compaction/compression, and fluid transport properties.

Grain Density Metals Measurement

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Grain density measurement of core samples is an important parameter that is used to determine the gas storage potential of rock reservoirs. Gas pycnometry is performed on intact cores or crushed samples to measure grain volume which, with the initial mass, yields grain density. Measured bulk and grain density are combined to deduce porosity.

A gas displacement pycnometer, with a larger sample chamber designed specifically to accept intact drill cores, provides a low-cost, time-saving, non-destructive technique for measuring the skeletal volume.

Knowing the envelope and skeletal volumes of a score sample allows the total pore volume percent porosity of the sample to be determined.

- Determine shale reservoir effective porosity
- Provide measurement of grain densities
- Calculate the saturation of free, or combination of free and bound fluids and water
- Estimate of water and volatile hydrocarbons in pore space

The AccuPyc High Pressure pycnometeris a fully automatic pycnometer that provides high-speed, high-precision volume measurements and density determinations on intact or crushed shale core samples

CorePyc designed for the specific needs of operations that require pore volume knowledge of intact sample cores.

Transition Metals Measurement

The use of NMR for geophysical characterization of core samples is well accepted. NMR provides information for diffusive characterization of shale samples in terms of fluid mobility, effective porosity, and to determine kerogen conversion.

Core samples contain significant amounts of metallic minerals that can contaminate NMR measurements and skew results. It is prudent to measure the metallic content of the core samples to make the analyst aware of any possible contamination. The experimental approach can then be adjusted as required.

The MA-1040 Magnetic Analyzerdetects and measures low levels of metalic iron, nickel, or cobalt content in sample materials.