Petrographic controls on shale surface area and the novel characterisation of pore structures.

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This research looks at the novel characterisation of pore structures within shales and determines the petrographic control on pore surface area in Utica and Marcellus shales. There's a growing demand on energy needs with increasing pressure to be environmentally aware and proactive. Shales provide an invaluable and abundant resource making up 75% of sedimentary basins (though not all 75% will provide an available resource). The surface area of shales is a significant property since 20-85% of methane is stored on the pore surface area, where the rest is stored within the bulk volume of the pore network. Novel techniques have been used to investigate these properties and Hg porosimetry has been used synergistically with DSC thermoporometry to de-shield pore sizes and probe the pore shapes within the samples, and also allows for the compressibility of samples to be assessed. For methane production and carbon dioxide storage, the surface chemistry of the pores for adsorption is also crucial. SEM MLA has been used to characterise the mineral quantities within the samples, and gas adsorption to determine the surface area (BET and DFT) of the shales and of individual minerals. These results can be combined into a homo-tattic patch model to numerically calculate which mineral is the dominant contributor in shale surface area. The adsorption of methane and carbon dioxide is strongly influenced by the heat of adsorption, which will impact the ability to displace and extract the gas-in-place. The significance of these results is the ability to determine which minerals are associated with larger surface areas of significance for gas-in-place estimations, since methane is primarily stored by adsorption on the pore surface. Hg porosimetry and DSC thermoporometry produce a variety of conclusions for different samples. Some samples have tight pore structures such that the Hg is unable to intrude the sample and there are is a null result in DSC, while others exhibit intrusion and the DSC on entrapped Hg permits de-shielded pore body size determination. However, there were no instances where sample compression was identified, thereby allowing us to assume that samples tested in laboratory environments have not undergone expansion during extraction from depth .Mineralogical results for Utica and Marcellus showed an inverse relationship between calcite and illite quantities. Utica surface areas were strongly correlated to the quantity of illite within samples - however when there was a large increase in the TOC% it caused an increase in surface area, and when there was a large increase in the quantity of siliceous material the surface area decreased. Marcellus surface areas were less strongly correlated to illite quantities, and the sample with the greatest surface area had the lowest TOC%, the median illite content, but greatest quartz content. These results were unexpected and further investigation is needed.