Effect of organic matter chemical properties on thermal maturation of organic rich shales: experimental approach.

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Résumé

Thermal maturity is often considered as the most important control factor of the development of the organic matter (OM) hosted porosity in gas shales systems. Nevertheless, this process is poorly understood and is insufficient to explain all the trends observed in natural sedimentary basins and others control factors as OM composition have thus to be considered. In view of the great contribution of OM-pores to gas storage capacity of these reservoirs, a better understanding of the role of OM properties and its chemical transformation is required. To this end, immature organic rich shales (Kimmeridge Clay, UK) were artificially matured using confined pyrolysis experiments to assess the porosity evolution from early oil window to dry gas zone. Porosity before and after maturation was measured by nitrogen adsorption and evaluated as a function of thermal maturity and shales composition (Organic petrography, Rock Eval analyses, XRD). The monitoring of OM chemical transformations was performed by GC/MS analysis of both oil and gas generated during pyrolysis experiments. The results revealed that the OM chemical transformations observed during pyrolysis experiments follow the trends observed in natural sedimentary basins. The Vitrinite reflectance (%Ro) estimated from Dibenzothiophenes and Phenanthrenes ratios confirmed that the desired degrees of maturity have been reached. OM-linked porosity, non-existent in immature shales, grows from the beginning of the wet gas zone to becomes predominant in gas-mature samples. However, a correlation between pore size variations and total organic carbon contents (TOC) is observed in gas-mature shales: samples containing a better OM intrinsic petroligenous quality (corresponding to high-TOC samples > 5 wt.%), developed smaller pores during maturation than low-TOC shales. These observations suggest that small variations in OM properties could greatly modified OM-pore network formed during thermal degradation process. Depending on the extent of these variations, the effect of maturity could probably be masked in some formations explaining the diversity of the trends observed in natural systems. Therefore, in this type II OM, thermal degradation process and OM intrinsic petroligenous quality seems to have a great control on the OM-pore genesis.

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