The Petrographic and Sedimentological Context of Pore Types in the New Albany Shale - SEM Observations on Ion-Milled Samples

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The New Albany Shale of the Illinois Basin is an important producer of natural gas with an estimated resource potential in excess of 100 tcf. In the principal gas producing areas the New Albany Shale is immature to sub-mature (RO ~ 0.5%), and gas producability is believed to be largely controlled by natural fractures. Yet, with a fracture spacing at the decimeter scale, gas still has to migrate some distance to these fractures and thus the intrinsic porosity of the shale is a crucial variable for sustained production. Samples from a New Albany well in southwestern Indiana were ion-milled and examined by field emission SEM for intrinsic porosity. Two principal types of porosity were observed: (1) pores defined by a framework of phyllosilicates and ranging in size from 50 nm to more than 1000 nm; and (2) dissolution pores of comparable size range that occur along the periphery of dolomite grains. Abundance of "Type 1" pores is a function of organic matter content and clay content. In high TOC shales (7-15% TOC) potential phyllosilicate framework (PF) pores are filled with kerogen, whereas in low TOC shales (less than 7% TOC) a large proportion of the PF-pores are open, likely connected, and potentially able to transmit gas. This type of pore is also more common as clay content increases, but more critically, their abundance hinges on the presence of pressure shadows generated adjacent to "hard" grains (quartz, feldspar, dolomite, calcite, pyrite) that resist compaction. "Type 2" pores must reflect a late diagenetic lowering of pH in the pore waters, possibly related to formation of carboxylic acids. When dolomite content is low (a few %) they constitute only isolated porosity. However, in shale intervals that contain abundant dolomite, and where dolomite grains are concentrated into laminae, "Type 2" pores may as well may facilitate gas migration. Samples from transgressive system tracts are largely devoid of Type 1 pores and Type 2 pores are typically isolated and do not help production. Shale samples from highstand system tracts and lowstand system tracts, however, contain abundant Type 1 pores and even intervals with elevated TOC values (5-10% TOC) contain enough clay to allow for open Type 1 pores.