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PSThe Influence of Basement Structures from Devonian Black Shale Thicknesses in the Northern Appalachian Foreland Basin*

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Abstract

Five thick black shales were deposited in western New York and northern Pennsylvania during the Middle and Late Devonian. Traditional models show the regional maximum black shale thickness successively steps farther west with the development of a gentle, structurally inactive clinoform. However, in the northern region of the Appalachian Foreland Basin, many of the areas of thickest black shale deposition coincide with areas of active faulting. From our outcrop studies in New York State and well-log analyses in New York and Pennsylvania we observed abrupt thickening of several of the black shales coincident with active faults that extend up from basement structures, primarily the Clarendon-Linden Fault System and Iapetan opening/Rome Trough structures. For example the regionally minor black shales the of Pipe Creek and the Hume formations are typically 1 meter or less thick and appear inconsequential as a reservoir/source rock. However, within the extent of the Clarendon-Linden Fault System, the Hume Formation averages 36m (120ft) thick, and the Pipe Creek Formation reaches 5.5m (18ft). More importantly for shale reservoirs, thick accumulations of the Geneseo (~45m/150ft) and Rhinestreet (91m/290 ft) formations coincide with basement structures of reactivated Clarendon-Linden, while higher thickness of the Marcellus (~56m/180ft) and Middlesex (~61m/200ft) correspond with the Iapetan-opening/Rome Trough structures.

We suggest that the combined stress of the Neo-Acadian collision and accompanying sediment loading reactivated the older basement structures, generating variable accommodation within the vicinity of the fault zones. In some cases, the thickening may result from thrusts that can be easily overlooked in the typical wireline logs if there are not distinctive marker units (as is typical in the black shales). However, such thrusts are recognizable in outcrop and FMI or similar logs. In addition to the increased localized accumulation of organic-rich shale, later fault reactivation would increase local fracturing, increasing the potential of these black shales as reservoirs and source rocks.