Marcellus Shale Deposition and Gas Production

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PetroEdge started drilling Marcellus Shale wells early in the play working in New York, Pennsylvania and West Virginia. One of the early maps built to assist in selecting areas for acreage acquisition and drilling was a gross thickness map. From the very beginning of the play. A critical question emerged. What is more important rock quality or gross thickness? The issue was particularly vexing because some of the early success in the play was in Southwest Pennsylvania and North-western West Virginia where the rock thickness is relatively thin, less than 80 feet. Did this mean that areas with Marcellus greater than 200 feet would yield more than twice as much gas?

To look at this issue a series of maps were made to look at the distribution of pore volume in the Marcellus based on legacy borehole log data and sparse core control of rock and geochemical properties. Like all shale estimation of porosity is complicated by the effect of uranium rich low density organic material (kerogen) on the density and sonic logs. Using established procedures it is possible to unscramble this relationship to use the logs to estimate both total organic content (TOC) and kerogen corrected porosity. With porosity known and a cutoff established it is possible to calculate the net pore volume and a net to gross ration. These maps show that some of the Marcellus pore volume in the thick portion of the isochore is reduced by a loss in rock quality leaving some of the areas either without increase in production proportional to rock thickness or with a decrease in productive capacity.

Early work on the logs demonstrated regional trends in apparent density of the kerogen that show increasing density with increasing thermal maturity as predicted from laboratory data. As the importance of organic porosity in shale structures became better understood, it became apparent that the TOC map could be of more importance as an indicator of the capability of the shale to generate porosity, than it is as and indicator of gas generation. Subsequent mapping illustrated the role of organic content in regional porosity development. It looks like the combination of increasing quartz input from the eastern source coupled with greater thermal maturity limits porosity development in those areas of the Marcellus with low net to gross ratio. These diagenetic processes led to a shale rock body with a distribution of density, velocity and rock moduli that seem to be controlled by the same combination of depositional and diagenetic system that control pore volume.

The Marcellus has trends for pressure compartmentalization and fracture behavior that appear correlated to stratigraphic features that locally override regional pore volume trends.