

## **Counter-regional detachment structures, southwestern Pennsylvania, central Appalachian basin: Implications for Marcellus Shale gas exploration and production**

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### **ABSTRACT**

3D seismic data in southwestern Pennsylvania, central Appalachian basin, demonstrate that the structures in the Devonian section are dominated by the east-vergent folds and reverse faults, which contrasts with the west-vergent ones that have been well known in the basin. Vertical (cross-stratal) variation in fold curvature and fault throw indicates an increase in contraction from Upper Silurian to Middle Devonian followed by a decrease from Middle Devonian to Upper Devonian. Lateral (along-stratal) variation in fold curvature and fault throw indicates a decrease in contraction from the east to the west. These observations, along with previously reported observations from wells and 2D seismic lines in adjoining areas, suggest a major post-salt, counter-regional detachment structure in the western central Appalachian that was most likely driven by gravitational pull from the east during the Acadian orogeny.

Marcellus Shale gas exploration and production data hint at a strong correlation of gas potential and productivity to natural faults from both local and regional perspectives. Locally, the gas productivity drops significantly towards major northeast-trending reverse faults. Regionally, the overall exploration activity decreases towards major northwest-trending cross-strike lineaments. This correlation is opposite to what was previously reported in conventional reservoirs in the basin. We interpret that in shale gas reservoirs, large-scale (> shale thickness) faults, particularly the cross-regional wrench faults, caused sustained leakage of released gas from the reservoirs, while small-scale ones (< shale thickness) could potentially retain the released gas in the reservoirs. We conclude that investigating the characteristics of natural faults is fundamental to the successful exploration for and effective development of shale gas in the central Appalachian basin.