

## **Empirical Evaluation of Procedures to Detect Spatial Anomalies in the Devonian Antrim Shale (Michigan Basin), and Potential Effects on Resource Assessment**

Timothy C. Coburn,<sup>1</sup> Philip A. Freeman<sup>2</sup> and Emil D. Attanasi<sup>2</sup>

<sup>1</sup>Department of Management Science, Abilene Christian University, ACU Box 29315, Abilene, TX 79699, coburnt@acu.edu

<sup>2</sup>US Geological Survey, National Center, 12201 Sunrise Valley Drive, Reston, VA 20192

During the past decade, drilling and fracturing innovations have helped to unlock vast natural gas resources in shale. However, while the resource in unconventional shale gas plays is assumed to be ubiquitous, it is not uniformly distributed in any geographic sense, and the locations of highly productive sites cannot be easily differentiated from less productive ones prior to drilling. For conventional plays, it has long been recognized that the detection of anomalies and trends can provide valuable information with which to reduce assessment uncertainty; but this principle has not proved to be entirely applicable to unconventional plays. The difficulty lies in the physical nature of the resource itself. Shale gas resources are continuous, but the gas is apparently unevenly distributed in a spatial sense and may be random-like in places. This characteristic of the gas distribution, coupled with variable drilling and completion tactics that affect recovery and producibility, renders anomalies and trends over extended distances difficult to track, and even masks their importance. If regional trends can be discerned, then such trends can presumably be used to aid the assessment process.

The primary objective of this study is to investigate empirical methods for establishing regional trends in unconventional gas resources as exhibited by historical production data and to determine whether or not the inclusion of such trends influences localized assessment results. To this end, the following two important questions are posited: (1) Can results of past drilling (i.e., well productivity) be used to confirm trends that might be inferred from available geological evidence, particularly with regard to naturally-occurring fractures? (2) Can information about such trends be used to inform the estimates of recoverable gas at undrilled sites as well as the aggregate assessments of remaining recoverable gas? These questions are addressed by using publicly available data from the Devonian Antrim Shale gas play in the Michigan Basin. Results from bearing correlation analysis and trend surface analysis based on cell EUR values are consistent with previous geological evaluations, and local spatial statistics indicate the existence of clusters of cells with similar values.