**Geologic Play Book for Trenton-Black River Appalachian Basin Exploration**

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**Current state of technology used in the play.** The Trenton-Black River gas play, a wide-spread play that encompasses an area from New York to West Virginia with additional potential in Ohio and Kentucky, is a seismic-dependent, high-technology, high-risk, deep play that has attracted national and international attention. Productive wells have been drilled in this play in New York, Pennsylvania, West Virginia and Ontario, Canada, but the nature of the play is not consistent among these various areas. In New York, production is limited to areas where hydrothermal dolomite has replaced host limestones in the Black River and lower portions of the overlying Trenton Limestone. Production in Ontario is from similar reservoirs. However, in West Virginia, production is associated with fractures and basement-deep faults that are not associated with dolomitization. The possible occurrence and extent of both types of reservoirs in Pennsylvania is not known at this time.

Currently, exploration programs are highly-dependent on the acquisition and interpretation of 2D seismic data, although 3D seismic has been shot in small areas of the play. Initially, geophysicists developed an exploration model, based on seismic, that required the presence of a basement-deep fault that served as a conduit for fluids that emerged from the basement and rose to the level of the Black River, and in some cases, the Trenton. These hot fluids dolomitized the host limestones, resulting in an overall volume reduction of rock. This reduction in volume, with a corresponding increase in porosity, was observed on seismic as a slight sag on the top of the Trenton Limestone.

As the play developed, although it is still in its infancy, it has become apparent that this model is too restrictive and is not applicable in all areas of the play. Therefore, other seismic models are needed to site wells and reduce the risk of drilling expensive dry holes.

Most of the wells that have been drilled in the play are vertical holes, drilled with rigs that are capable of reaching depths of 10,000 to 15,000 feet, and equipped to handle reservoir pressures that may be twice the normal hydrostatic pressure in some locations. Recently, however, some operators have begun to drill horizontal wells, some of which have proven to be quite successful. Others, however, have been expensive failures.

Given the depth, expense and potential of these wells, it has been a fairly standard practice to run a sophisticated log suite, including mud logs, but few, if any, cores have been taken. The logs are interpreted by company employees and by consultants, some of whom normally operate outside this basin. Service companies who complete these wells have attempted techniques and approaches that vary from well-to-well, or company-to-company, or state-to-state.

**Technical problems associated with the play.** The relatively few wells that have been drilled in this play in New York currently are responsible for 50 percent or more of the gas produced in that state, attesting to the importance and future potential of the play. However, success rates in both New York and West Virginia could be improved, and an examination of production records indicates that adjacent wells vary greatly in performance. In fact, a very small percentage of the productive wells produces a very high percentage of the gas in the play. So, nearly 5 years after drilling in the play accelerated following additional discoveries in New York and West Virginia,

operators continue to struggle to locate productive wells and eliminate poor producers and dry holes. It is very hard to hit good wells. The targets are narrow, and offset wells are of differing quality.

Even the use of 3D seismic and horizontal drilling has not yet been able to increase success rates significantly, although it may be too early to accurately judge the success of these technologies. At least one well drilled on a 3D prospect was marginal; it is too early to evaluate others. Several horizontal wells have proven to be prolific producers, but others have been reported as marginal, or even dry.

At present, we are unable to predict the extent of dolomitization, or understand why it is prevalent in some areas, but is not present in others. We have yet to determine the importance of the basal sandstone: is it a necessary pre-requisite for a dolomitization model? And, if it is, where is it present, and where is it absent? Finally, we do not know if reservoirs in Pennsylvania will be similar to those in New York, which are highly dolomitized, or like those in West Virginia, which are fractured limestones, or both.

**Why new technology is needed**. For the play to continue to develop, operators need to improve their success rates and the quality of wells that are drilled and completed. This will reduce exploration costs and finding rates. To achieve these goals, industry need to develop better subsurface imaging/visualization tools that are absolutely necessary to site wells. We also need to develop tools and techniques to "high-grade" the vast play area, to prioritize acreage and designate trends in which seismic programs should be concentrated.

We need to understand more about how the various reservoirs developed, the source of the gas in the reservoirs, and the timing of reservoir filling. All of these elements are important parts of an integrated, basin-wide exploration model.

**Goals of the R&D project.** One of the goals of the current research effort is to better define potential areas within the broad area currently defined as the Trenton-Black River play area. A second goal is to provide a definition and description of the different plays, or reservoir types, that we can expect in these more restricted areas.

We will suggest areas in which companies should focus their expensive seismic programs. We will accomplish this by producing and providing our industry partners with better subsurface maps, especially maps of basement-deep faults and the distribution of the basal sandstone.

We will develop better descriptions and an understanding of the various types of reservoirs that are present in the play, and an understanding of their formation over geologic time. This will lead to a model that can more accurately predict where these different types of reservoirs may be located and how they should be completed and produced.

We will develop a better understanding of the source of the gas or individual gases, within Trenton and Black River reservoirs, and how and when these gases migrated into the reservoirs. This will help to predict locations where gas may not be present.

We will compile of all the known data and information on the Trenton-Black River play, and combine it with our results in one searchable location on our project website. Eventually, this website will be available to everyone.