Pittsburgh Geophysical Society

DATE: Tuesday, December 7th, 2010

PLACE: Radisson Hotel - Greentree
101 Radisson Drive, Pittsburgh, PA 15220
412-922-8400

TIME: 5:00 PM – Social Hour
6:00 PM – Dinner
7:00 PM – Speaker

COST: $30.00
PAYMENT: Cash or Checks at the door. Please make checks payable to "Geophysical Society of Pittsburgh"

DINNER OPTIONS:
Breast of Chicken Scampi, Garlic in a Lemon Butter Sauce, includes salad, bread, and dessert of Carrot Cake. Coffee, Tea, Decaf Coffee, Iced Tea.
Or
Roast Pork Loin, Herb Crusted with Apple Chutney, Chef's Selection of Seasonal Vegetables, includes salad, bread, and dessert of Carrot Cake. Coffee, Tea, Decaf Coffee, Iced Tea.

RSVP by November 26th, to Mr. Philip Towey
(email:Philip.Towey@cabotog.com)

Presentation:

SEISMIC APPLICATIONS IN THE MARCELLUS SHALE PLAY

James R. Morris, Director of Geophysics, Range Resources MSD

Introduction

With approximately forty five thousand square miles of prospective shale pay area, mainly in Pennsylvania, but also covering lower New York, and north central West Virginia, Marcellus Shale reserves have been estimated as high as 489 TCF (Engelder 2009). The prospective areas of Marcellus Shale lie under the Allegheny Plateau, west and northwest of the Allegheny Structural Front, where several devonian formations outcrop, including the Marcellus. Gross thickness of the Marcellus, across the Allegheny Plateau where most Marcellus wells are drilled, ranges from less than 50 feet to roughly 300 feet.

Northcentral Marcellus Play Characteristics

In the northcentral Marcellus Shale play area, there are more proprietary and spec/multi-client 2D and 3D seismic surveys being acquired than in the southwest. This area is within 60 miles of the Allegheny Structural Front and within the thickest part of the Salina Salt basin. Large salt cored thrust faults, with up to 2,000 feet of offset, cut the Marcellus. These salt cored thrust faults ramped upwards over near vertical faults originating from the Precambrian, but were active right up through the Silurian Lockport, near the base of the salt. Salt cored thrusting usually resulted in "Compressional Grabens", with either a northwest or southeast side being dominant. This preferred dominance can change along the strike of the anticline and is usually affected by the throw of the Precambrian through Lockport faults. Almost all Marcellus operators acquire some kind of seismic data, from vintage 2D to modern 3D before drilling, especially in the fold belt region. Acquiring 3D seismic can be quite a challenge in the rugged terrain of northcentral Pennsylvania where 1000 feet of elevation change can occur between boulder capped ridges.

Southwestern Marcellus Play Characteristics

In the southwestern Allegheny Fold Belt, there may not have been enough salt to accommodate all of the Alleghenian compressional forces. Thrust faults affecting the Marcellus Shale are salt cored with evidence of secondary decollements in the shales themselves. The velocity of the Marcellus Shale in the southwest is in general slower than the northeast. Another distinction, in the far western Allegheny Plateau, is that the Marcellus can be subdivided into two stratigraphic units, an Upper Marcellus and a Lower Marcellus (Figure 1). The Lower Marcellus acts much like a salt decollement within this area, creating small horst blocks within the lower devonian. The detection and/or resolution out of the Upper and Lower Marcellus and these small horst blocks can only be imaged with high resolution seismic, either 2D or preferably, 3D. Horizontal wellbores encountering these small horst blocks can experience problems geosteering, depending on fault throws. Also, even nearby horst blocks can act as frac barriers. More natural fracturing may also be expected, which may be good or bad, depending on your reservoir model.

High Resolution 3D Seismic Applications

Beyond imaging faults, large and small, additional information can be extracted from high resolution, 3D seismic data. The western Allegheny Plateau sits on the western boundary of the Rome Trough and is dissected by numerous northwest to southeast cross strike discontinuities, the largest one being the Washington Lineament. These deep seated features appear to have influenced shallower structures right up through coal deposition time. 3D structure, 3D coherency, and 3D curvature maps on the Marcellus, and encasing formations, all show the footprint of these deep features on the Marcellus Shale, and can divide the shale into structural provinces. These lineaments, structures, and structural provinces, along with isochrons of the Upper and Lower Marcellus, can provide important insights to well performance. High fold, wide azimuth 3D seismic data has also shown to be a good candidate for "3D Azimuthal Fracture Processing". The derived "Fast Velocity Direction" which is parallel to the original open fracture azimuth, can be calculated and used to orient horizontal well direction. Finally, ongoing rock physics

studies are attempting to extract reservoir properties such as permeability, porosity, etc. to map Marcellus "sweet spots".

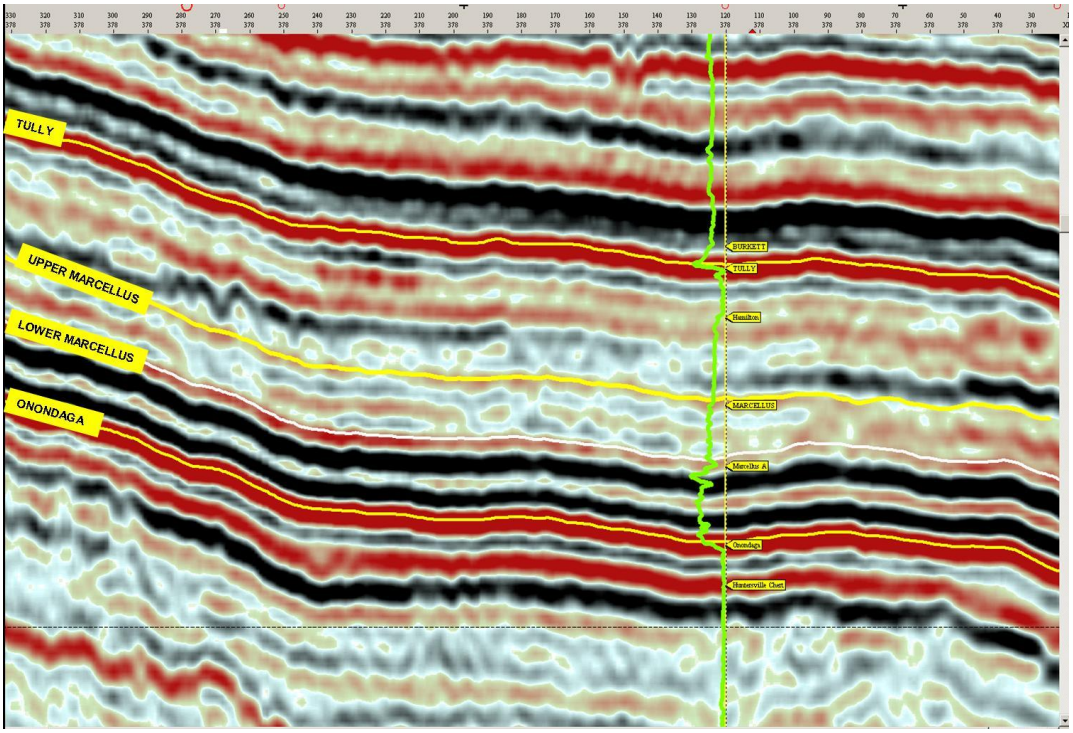

Figure 1. Spectrally Enhanced Inline from 3D seismic survey in western Pennsylvania showing vertical resolution of upper and lower Marcellus Shale units.