Oil & Natural Gas Technology

DOE Award No.: DE-FE0009904

Quarterly Research Performance Progress Report (Period ending 09/30/2013)

Structural and Stratigraphic Controls on Methane Hydrate occurance and distribution: Gulf of Mexico, Walker Ridge 313 and Green Canyon 955

Project Period: 10/01/2012 – 09/30/2015

Submitted by:
Priyank Jaiswal

Signature

Boone Pickens School of Geology, Oklahoma State University
DUNS # 049987720.
Stillwater, Oklahoma 74075
e-mail: priyank.jaiswal@okstate.edu, Phone number: (405)744 6041

Prepared for:
United States Department of Energy
National Energy Technology Laboratory
Submission date: May 03, 2013

Office of Fossil Energy

Phase 1, Subtask 5.1

This report encompasses description of the final seismic processing steps for optimum outcome of depth images, for Green Canyon and Walker Ridge 3D seismic volumes. This is an attempt to further augment the quality of the 3D images, without applying excessive seismic processing, and thus complying with the true geological picture of the respective fields. This is achieved by fine grid velocity profiles and meticulously picking subtle changes on semblance plots. The velocity profile is then smoothed for subsequent 3D Pre-Stack Kirchhoff Depth Migration.

Super gather Formation:

Previous Depth Migrated sections were obtained using relatively coarser grids. The objective was to pick velocities on profile with gentle dips, and avoiding complex geological patches, in order to make a uniform velocity model. The successful formation of 3D Depth Sections, gives an estimate of the geological features which were pronounced, and assisted in focusing our research on areas of less illumination. The initial depth migrated sections were consistent to the images provided by DOE, and validates the parameterization of our Kirchhoff Depth Migration algorithm. A finer 3D grid is used to give a more accurate estimate of the velocities.

This is achieved by transforming data into super gathers, but at a more consistent and finer grid. Since the data was supplied with geometry coordinates loaded, a post stack 3D geometry is run on ProMax. A grid is defined from the dataset over which super gathers are to be formed. The origin point, starting and end points of grid are given, by seeking information from traces headers. The grid is made, to ensure that all possible stacks are formed, from the given datasets.

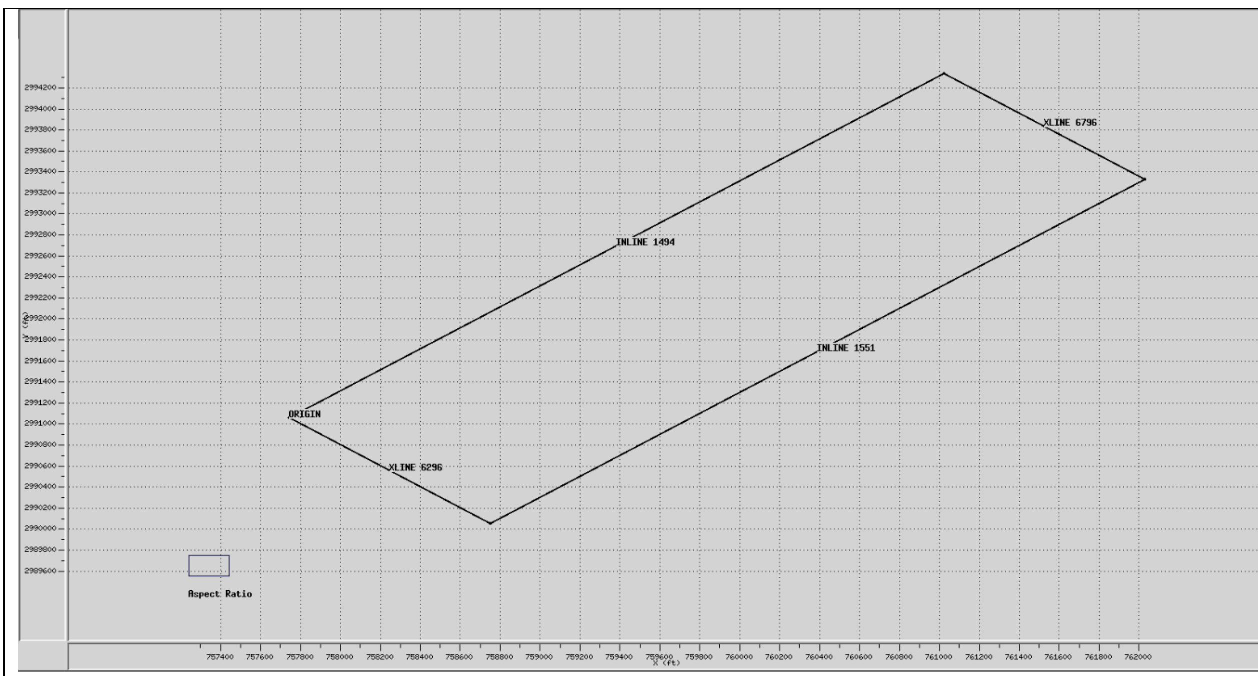

Figure 1: Grid Map of Green Canyon

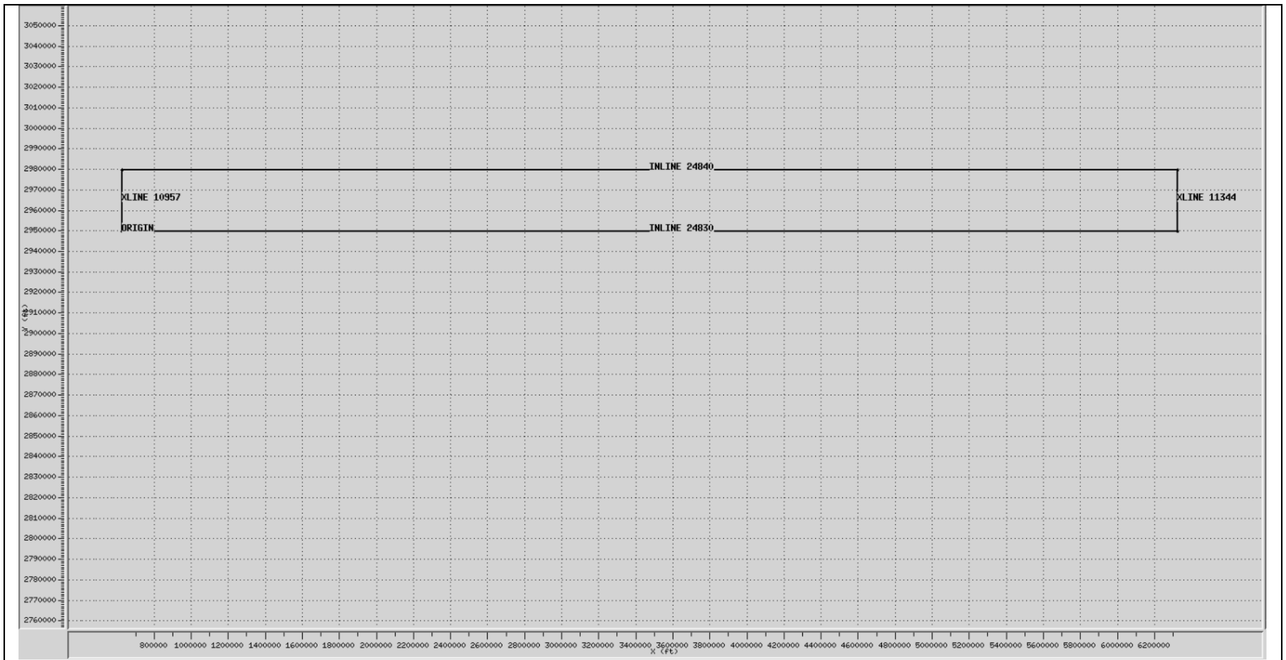

Figure 2: Grid Map of Walker Ridge

A grid with inline range of 1494 to 1551 and cross line range of 6296-6796. Similarly, an inline range of 24830 to 24840, and cross-line range of 10957 to 11344 is selected for Walker Ridge. Super gathers are constructed by keeping an increment of 1 for Inlines and 25 for cross line. This is carried out to ensure finer velocity picking.

Velocity Analysis:

The pre-compute velocity analysis job is carried out to make Constant Velocity Stacks (CVS), which are used in picking velocity. These CVS stacks have partial Normal Move-out (NMO) applied, using range of velocity values. Semblance is another important tool to validate our picks at different depths. It represents the cluster of amplitudes in contours, which represents horizons occurring at all depths. A semblance range of 1000 and 8000 suffices, covering all possible cluster of energy.

Velocity panel:

Before commencing velocity picking, stacks are made, and are interpreted to estimate velocity values at different depths. Water Bottom and Bottom Simulating Reflector are also marked, which are referenced in Velocity Panels. Although, the dataset has surface multiples attenuated using SRME, some remnant energy is present. A caution is practiced while picking times at deeper depths, to avoid multiple energy.

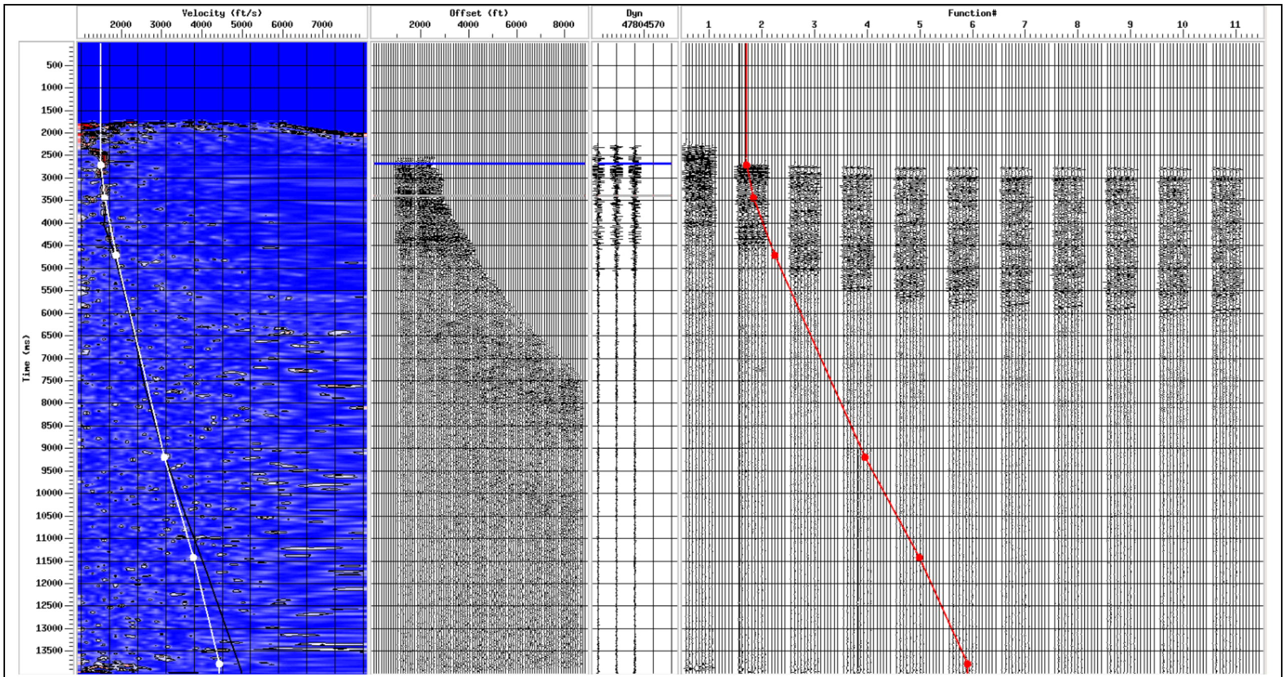

Figure 3 : Velocity Analysis of CMP along inline 1498

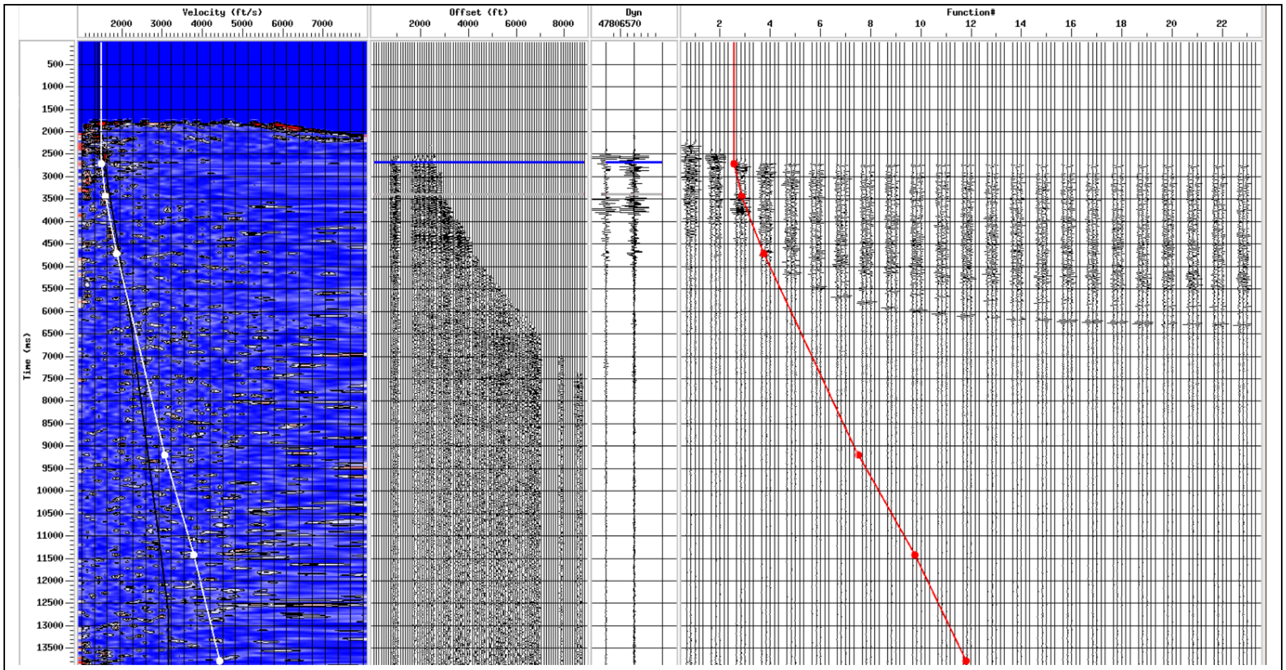

Figure 4: Velocity Analysis of CMP along inline 24830

The final velocity is selected after rigorous revision and examining the velocity profile. Each revised velocity is used as reference velocity for the next velocity analysis. A great deal of caution is exercised in picking velocities at locations with high angle dips and complex geological structures. The finer Velocity grid enabled to pick events representing subtle lateral variations in semblance plots. The Final RMS Velocity Profile is further smoothed using 3D velocity viewer, for optimum functioning of depth migration algorithm. The smoothed RMS velocity is converted into Depth Interval Velocity, using Dix equation, which is required for Kirchhoff Depth Migration Algorithm.

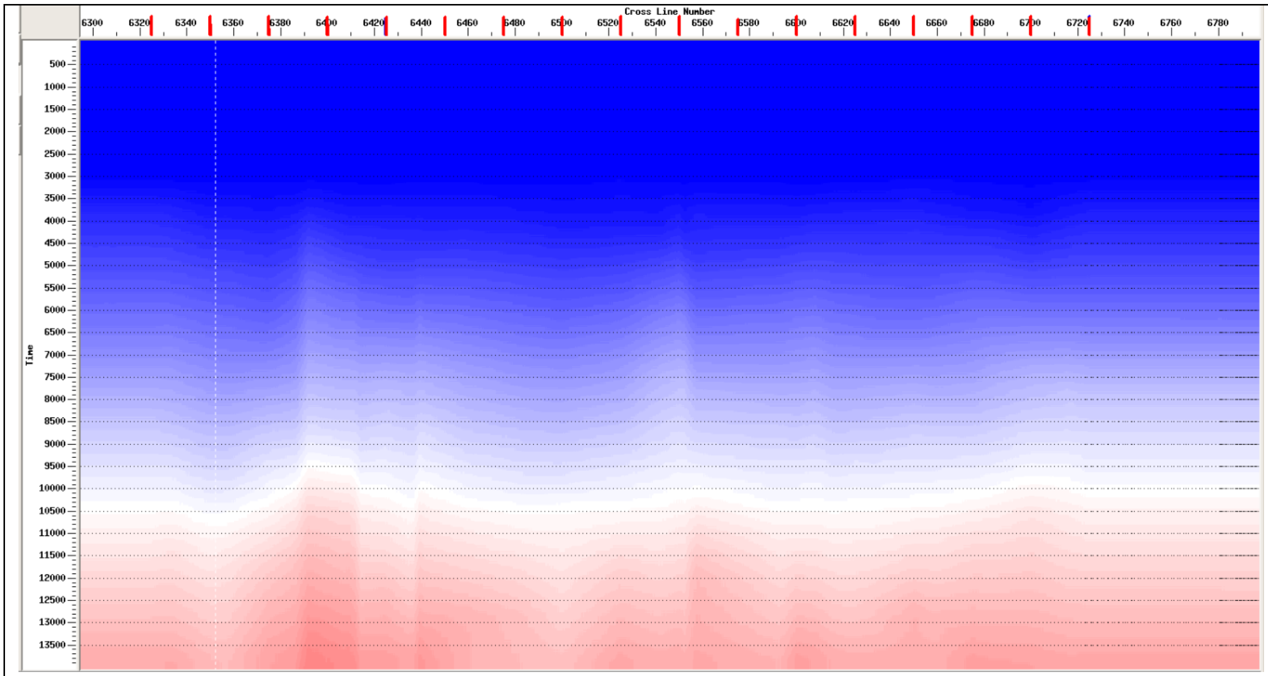

Figure 5 : Green Canyon Velocity Profile along Inline 1498

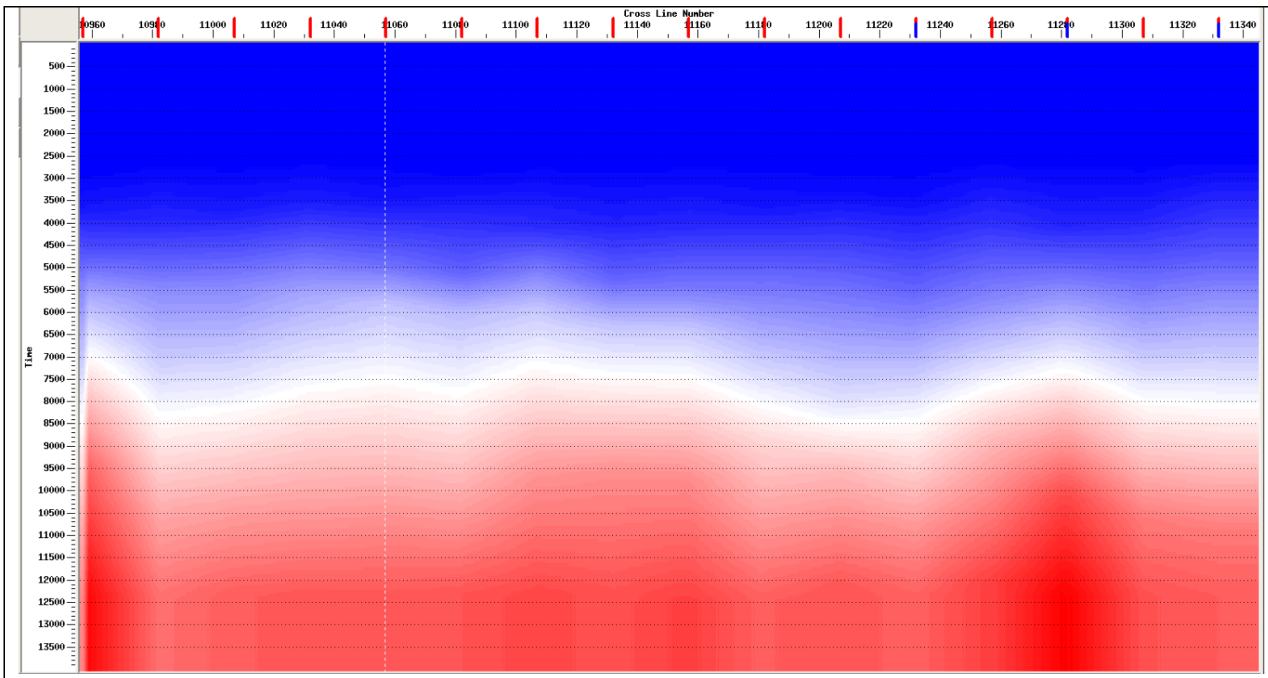

Figure 6: Walker Ridge Velocity Profile along Inline 24830

Common Offset:

After final selection of velocity, that data is all set for the final depth migration. The input data for depth migration is in common-offset domain. This is achieved by applying Normal Move-Out Correction, to flatten the traces, which is followed by formation of Common Offset Gathers. A common offset of 75 meter is selected, which can be used for both Pre-Post Stack Time & Depth Migration.

3D Pre-Stack Depth Migration:

Depth Migration is the most successful algorithm for illuminating subsurface in Gulf of Mexico. Depth Migration is suitable for datasets which presents lateral velocity variations. Also, due to presence of doming structures, the diffracted energy is not hyperbolic, which is a pre-condition for successful application of migration algorithms. Potential presence of deeper salt diapers in Green Canyon dataset in evident from the anticlinal structure in Figure 7, which is also consistent to Gulf of Mexico geological setup. These problems presents challenge in collapsing diffracted energy, which is required for resolving subsurface features. Unlike Time Migration, RMS Stacking velocities are converted to Depth Interval velocity using Dix Equation. The Depth Interval Velocities are used for final Depth Migration.

The complex geology and high angle dips poses problem for collapsing diffracted energy. 3D Pre- Stack Kirchhoff Depth Migration is applied, since it is suitable for higher angle dips as steep as 90 degrees. The spectral Analysis of the dataset reveals maximum frequency up to50-60 HZ. Therefore, PSDM is applied for Maximum Frequency of 50 Hz. A migration aperture of 5000 meter is selected, which is wide enough to collapse all the diffracted energy. The migration is run up to the depth of 14000 meters. An implicit Eikonal algorithm is used for carrying out PSDM, which predicts and estimates the wave propagation response in the subsurface. The migration process takes significant processing time.

The report presents two Inlines 1498 and 24830, from Green Canyon and Walker Ridge Concessions respectively. However, the 3D Pre-Stack Depth Migration volume has number of Depth Migrated Stacks for Green Canyon and two stacks for Walker Ridge. The dataset has been processed using consistent velocity grid profiles and uniform parameterization.

The report concludes the first phase of the project. Optimum 3D Depth volumes are attained for Green Canyon and Walker Ridge Concessions, using Conventional Seismic Processing. The 3D Depth Migrated volumes will serve as initial models for traveltime and full waveform inversion methods. It is anticipated that the 3D Depth volumes will be more refined and subsurface features will be further resolved in the later phases of this work. We also think that the Green Canyon data are better quality than Walker Ridge.

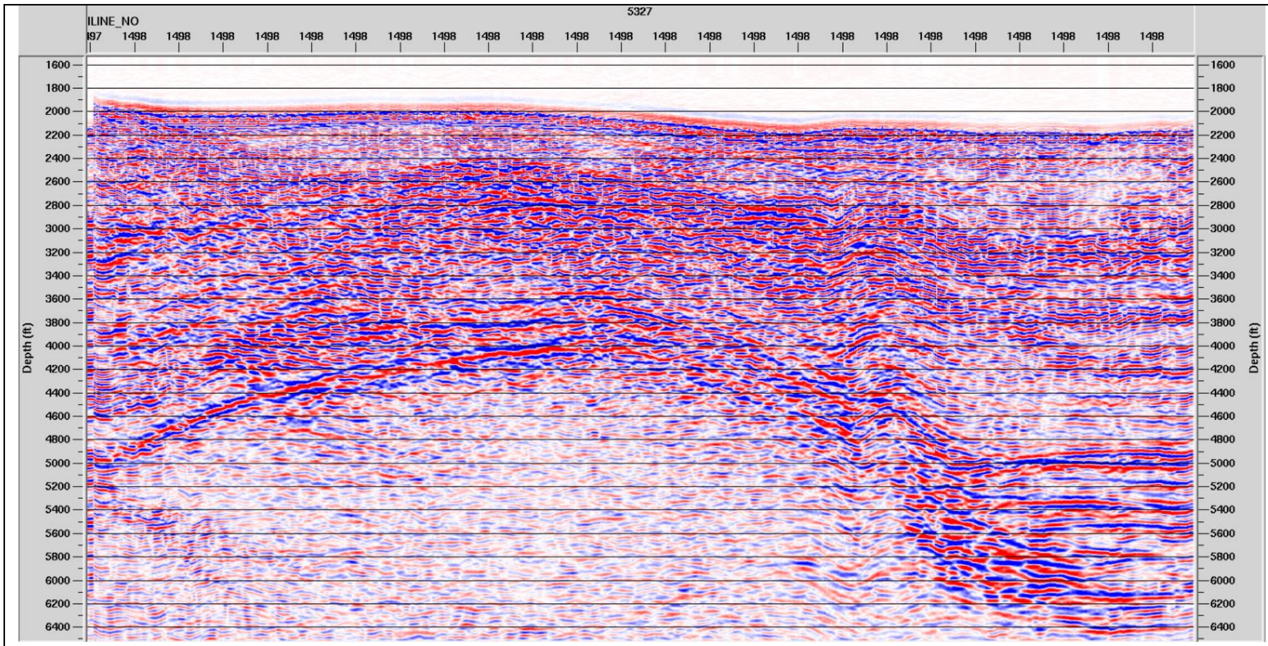

Figure 7: 3D Depth Migrated Section of Inline 1498 (*Green Canyon*)

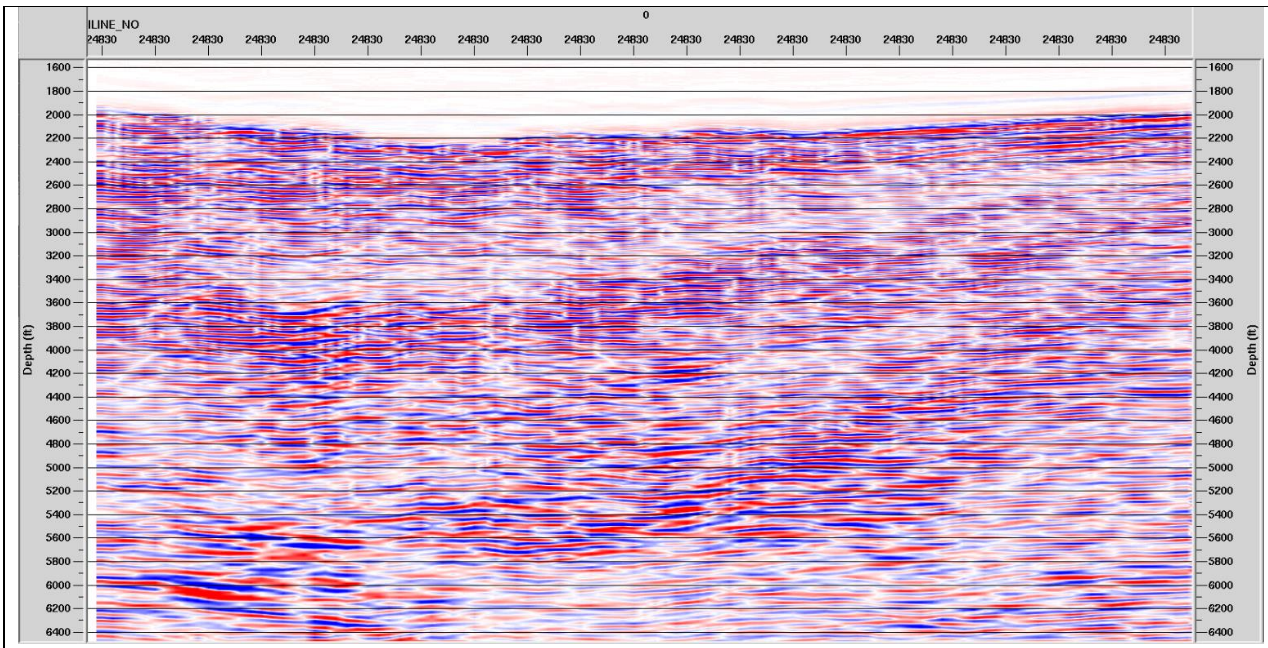

Figure 8: 3D Depth Migrated Section of Inline 24830 (*Walker Ridge*)

National Energy Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

13131 Dairy Ashford Road, Suite 225
Sugar Land, TX 77478

1450 Queen Avenue SW
Albany, OR 97321-2198

Arctic Energy Office
420 L Street, Suite 305
Anchorage, AK 99501

Visit the NETL website at:
www.netl.doe.gov

Customer Service Line:
1-800-553-7681