# Investigation of deep water GOM subsalt imaging using anisotropic model, dataset and RTM PSDM - Tempest

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Performing depth imaging is an essential part of deep water GOM exploration. Over the years, depth imaging technology has provided reliable seismic images below complicated salt bodies and has been implemented in workflows for prospect generation. However, we normally don't investigate the accuracy of depth migrated volumes. In order to learn about the accuracy of deep water GOM model building and depth imaging, we created a 3D VTI anisotropic earth model and 3D seismic dataset representing true subsalt GOM geology. The model and dataset are referenced as the Tempest dataset. The original project was done in three phases. This talk will focus on the fourth phase of the Tempest project – the anisotropic model, dataset and RTM PSDM.

The Tempest Project was initiated a few years ago in an effort to analyze the accuracy of depth imaging technology applied in deep water GOM. The project was executed in three phases. The first phase included design and construction of a realistic deep water GOM geological model, and simulation and imaging of the dataset using the known velocity model. Phase two was to provide the simulated data to several processing companies who regularly process data for Devon and have them construct a model and apply prestack depth migration as if the data were real GOM field data. The third phase included interpretation and analysis of the depth imaged volumes to (1) compare the derived prestack depth migration results to results achieved using the exact earth model, (2) compare the developed models to the exact model, and (3) compare the synthetic imaged data to field acquired datasets (see The Tempest project – Addressing Challenges in Deepwater Gulf of Mexico depth imaging through geologic models and numerical simulation, Seitchik et. al., 2009, TLE, pp. 546-553). Our talk here describes the fourth phase of the Tempest project – the new anisotropic model, dataset and RTM PSDM.

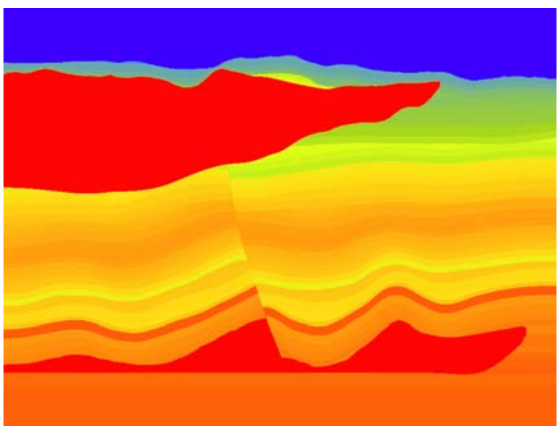

*Figure 1: A velocity inline display from the Tempest anisotropic model.*

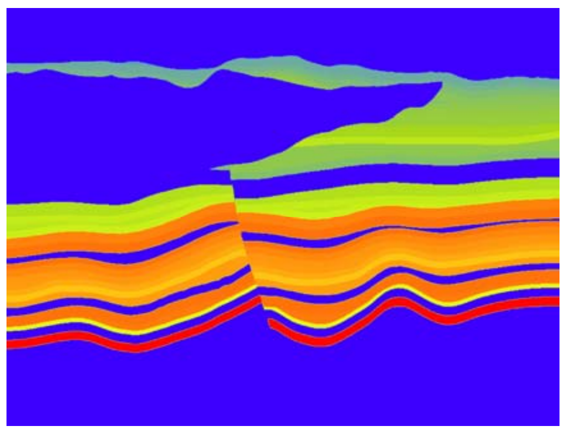

*Figure 2: A delta inline display from the Tempest anisotropic model.*

Several new data acquisition, processing and depth imaging technologies were introduced to the industry in the past few years. These include (a) use of WAZ data, (b) use of RTM as the leading tool for PSDM, (c) a move from isotropic model building and depth imaging to anisotropic model building and depth imaging, and (d) development and use of more sophisticated demultiple techniques, mainly for removal of surface related multiples. Leveraging lessons learned from the isotropic Tempest model and dataset, we decided to upgrade the model and simulated seismic dataset so that it can be used in the testing, evaluation and assessment of these new technologies.

The new Tempest model is a fully VTI anisotropic model (figures 1, 2). This model was constructed using actual well data and is a calibrated representation of the deep water GOM exploration setting involving complex salt bodies and clastic stratigraphy. VTI anisotropic acoustic wavefield simulation was used to create the new anisotropic dataset. In order to use the dataset for investigation of WAZ acquisition designs, each shot was recorded over a large areal extent (16Km x 8Km area). This enabled us to extract subsets of the full dataset in order to test the effects of sampling decimation on signal processing, as well as imaging and interpretation outcomes using a variety of different acquisition scenarios. The dataset was also recorded using the free surface boundary condition so it can be used to investigate new multiple elimination techniques (see figures 3, 4).

The main tool used for the depth imaging process of the anisotropic Tempest dataset is a VTI anisotropic RTM imaging algorithm (shown in figures 5, 6). During the past few years, anisotropic RTM PSDM has become the leading depth imaging algorithm used for imaging of GOM data. By having a synthetic anisotropic RTM PSDM volume and a known velocity model, we can quantitatively measure the accuracy of the anisotropic model building and depth imaging techniques that are routinely used with real field data and new depth imaging workflows applied for subsalt exploration. For example, we can measure the area of low illumination around a salt stalk, as well as the seismic artifacts that are present in the vicinity of vertical salt stalks (see figures 7, 8). This can lead to a much better understanding and interpretation of real field data.

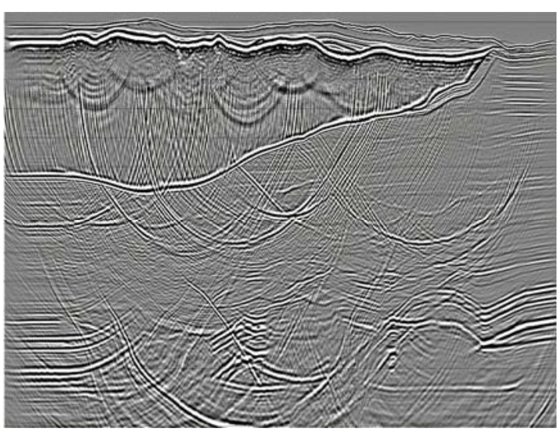

*Figure 3: Depth migrated section resulting from inputting of a 400m crossline tile subset of the data. PSDM is done using a Kirchhoff summation algorithm. The multiples migrated at the subsalt section are a result of both surface related as well as inner bed multiples.*

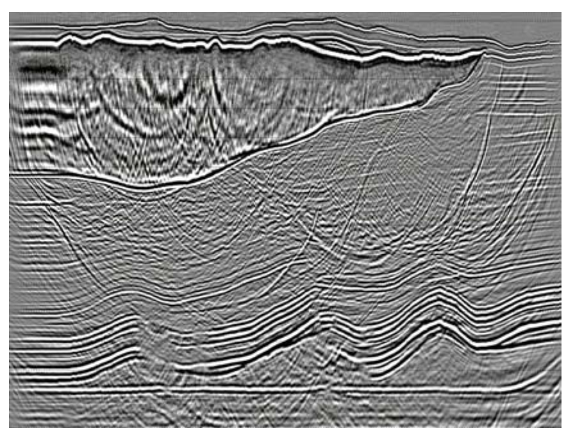

*Figure 4: Depth migrated section resulting from inputting 4Km crossline tile subset of the data. PSDM is done using a Kirchhoff summation algorithm. Compared to the section shown in figure 3, multiple energy is reduced due to the better sampling of multiples.*

In our talk, we will present the anisotropic model and dataset, show the RTM implementation and demonstrate the methods we are using to analyze and quantify the accuracy and resolution of the anisotropic depth migrated datasets. More importantly, we will show how the use of a full 3D synthetic anisotropic dataset for testing new acquisition and depth imaging technologies will lead to a better understanding of the advantages and shortcomings of these modern exploration techniques while providing key insights into the accuracy, resolution and limitations of the anisotropic models that we currently construct when using field acquired seismic data.

**Acknowledgments**

The original Tempest data was provided courtesy of Devon Energy Corporation.

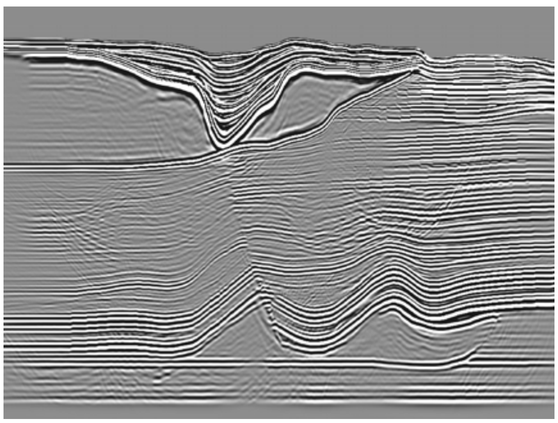

*Figure 5: A vertical section display from the Tempest anisotropic RTM volume. The entire dataset was used in the RTM run which produced this image.*

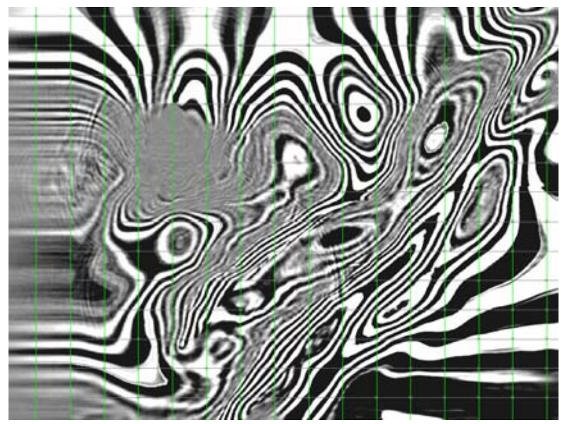

*Figure 6: A depth slice display from the Tempest anisotropic RTM volume. The entire dataset was used in the RTM run which produced this image.*

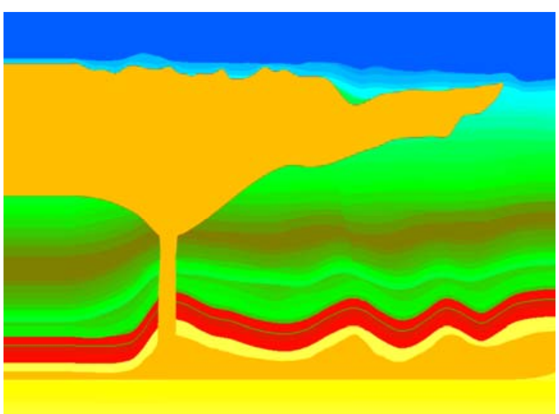

*Figure 7: A geological velocity model at the area of the narrow salt stalk.*

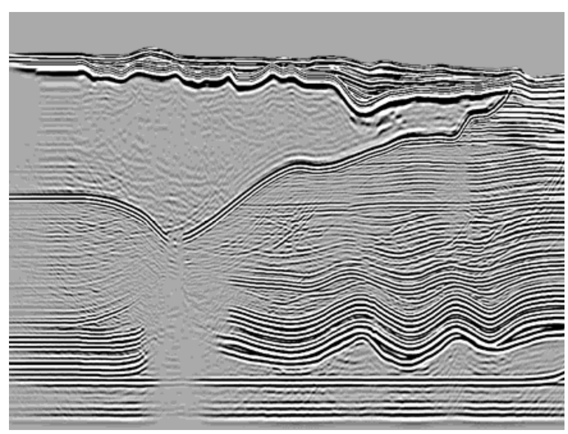

*Figure 8: RTM PSDM image of the seismic data at the area of the narrow salt weld. From this result we can quantitatively measure the area of low illumination around the salt stalk.*