Resolving Complex Salt Geometry:
Iterative Salt Imaging and Interpretation

Gabriel Ritter
Interpretation Project Leader
CGGVeritas, 10300 Town Park Dr,
Houston, TX 77072
+1 832 351 8296
gabriel.ritter@cggveritas.com

Kenneth Waddell
Senior Seismic Imager
CGGVeritas, 10300 Town Park Dr,
Houston, TX 77072
+1 832 351 1056
kenneth.waddell@cggveritas.com

Abstract

Introduction

Wide Azimuth acquisition (WAZ) combined with imaging algorithms such as CBM (Ting, 2008) and RTM (Zhang, 2009) continue to provide better images than ever before. In order to take full advantage of this latest leap in technology, we need an innovation of the model building flow by enhancing the ability to resolve complex salt geometries. Utilizing an iterative, result based workflow allows an experienced interpreter to converge on the best possible image.

The Method

Typically, the interpretations that closely correspond to the local and regional geologic settings result in the best images. However, understanding the implications of the local and regional geologic settings and applying that knowledge effectively is not always straight-forward. For example, a skilled seismic interpreter must be able to recognize the difference between a diapir and a bucket weld. An interpreter must also be able to differentiate whether a local high in the salt base is real, or if the brightest event is really a suture, as we see in the example from Han Sur (Figure 4).

Often complex salt can lead to a lack of illumination, resulting in a poor seismic image. This image degradation severely hinders the interpreter’s ability to develop a complete and coherent salt interpretation. These salt interpretation experiences have lead to the development of a robust salt interpretation workflow, which we feel allows us to arrive at the best possible solutions for ambiguous salt geometry. This workflow - rooted in geology - utilizes CBM, RTM and advancements in processing power to perform multiple scenario tests that allow us to converge on the correct salt interpretation in complex areas.
Identifying an imaging issue due to incorrect salt geometry can be a challenge in itself. We are looking for broken or distorted subsalt events (Figure 4a), or even subsalt areas that are lacking events. We must then evaluate what interpretation options are available and if clues from the initial migration may indicate one direction over the other (e.g. a break in the subsalt events may indicate that more salt is necessary). Once the plausible options have been evaluated and a course of action has been determined, interpretation for the various scenarios can begin. During this process it is important to develop scenarios that not only address the geophysical problem but also fit the geologic setting. Once migrated, the scenario testing results must be evaluated. Sometimes this is straightforward with one option clearly providing the best image (Figure 4b). But, just as often, a good scenario result indicates further improvement can be achieved. Thus the process repeats. Once a result is reached that solves the geophysical problem and most closely corresponds to the local geology, it can be incorporated into the final model and model building can continue.

Application and Results

Han Sur located 95 km North of Ciudad del Carmen (Figure 2) presents the perfect opportunity to apply an iterative salt scenario workflow. With its multi-tiered salt stalk canopy the imaging and interpretation challenges are immense. The extent of mobile salt bodies can clearly be seen in the top of salt map (Figure 3a) and its surface expression in the water bottom map (Figure 3b).

The recently-completed Fast Track program presented the first opportunity to attempt salt scenario testing in this area. While not as intensive as a production model building program, initial results were promising. Preliminary salt interpretation (Brown Region in Figure 4a) resulted in a subsalt image with poor continuity and “broken” structure. Two salt scenarios (red and blue dashed lines in Figure 4a) were then tested. After evaluating the results, an updated salt geometry was incorporated into the final model. - Figure 4b shows the migrated image overlaying salt geometry (Brown Region). The subsalt image continuity is clearly improved.
Conclusion

The combination of skilled, geological interpretation and a robust scenario testing method has shown to be highly effective in resolving complex salt geometries. This method provides an experienced interpreter with the framework to achieve the best results in the shortest amount of time.

Figure 3. 3a. Left, Han Sur Top of Salt Map. 3b. Right, Han Sur Water Bottom Map.

Figure 4. 4a. Left, Initial Salt interpretation with alternative scenarios. 4b. Right, Final salt interpretation. Data courtesy of PEMEX processed by CGGVeritas.
References

Ting, Chu-Ong, and Wang, D., 2008, Controlled Beam Migration applications in Gulf of Mexico: 78th Annual International Meeting, SEG, Expanded Abstracts, 368

Zhang, Y. and Sun, J. [2009] Practical issues of reverse time migration: true-amplitude gathers, noise removal and harmonic source encoding; First Break, 27(1), 53-59