Application of Integrated Interpretation, Modeling and Structural Restoration Workflow for an Extensional Basin Interpretation

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Summary

Application of 3D geological structural modeling plays an important role in understanding the complex geological structure from geology and seismic data. Structural modeling is one of the most efficient way to build the non-simplified structure in less time to do a restoration for each horizon and each geological time. This paper presents an application of structural modeling method combined with fault modeling, horizon modeling and zone generating steps.

Seismic interpretations can be a challenging task in complicated structural cases as today's structural framework should take into consideration all past tectonic events.

We propose a novel workflow that integrate interpretation, structural modeling and restoration together, and greatly reduces the difficulty of seismic interpretation and makes possible to identify and pick depositional features in the seismic data.

Introduction

The case presented is a part of north step-fault zone of an extensional basin, covering 350Km^2 with 100 faults (Figure 1). Truncation relationships are complex resulted from two-phase tectonic activity. Complex fracture system and ambiguity displayed by seismic data increase difficulty of structure interpretation, especially, in the down deep portion which is affected by tectonic movements of complexed nature.
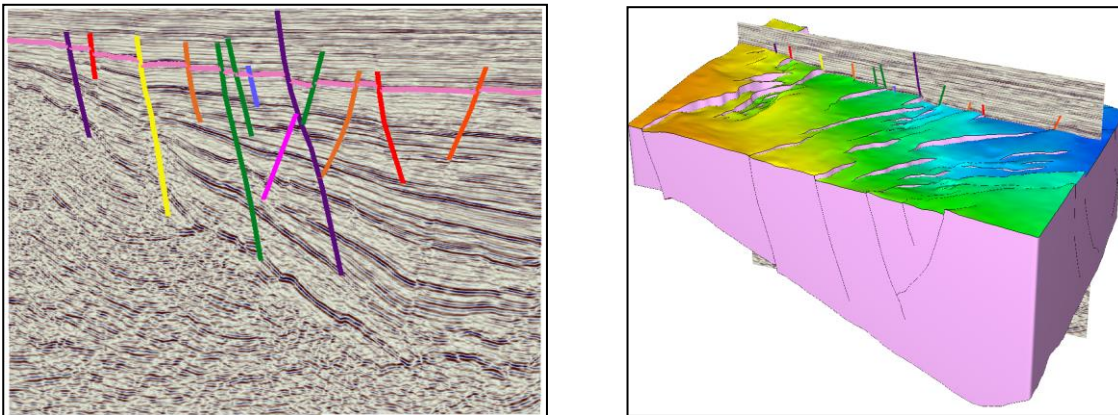

Figure 1

Theory and/or Method

Integrated workflow helps in accurately reveal the geology at the time of deposition. This restoration of integrated workflow is different from the Rigid Body Assumption (RBA). RBA means that the bodies are rigid, which means that they do not deform under the action of applied forces. This restoration achieves its result by performing Deformation Body Assumption (DBA), which is a fault blocks sliding (seamless and non-embedded) restoration process based on finite element analysis of elastic mechanics. DBA includes bodies that display fluid highly elastic, and plastic behavior and receive better result.

In this method, multiple restorations (i+1) can be performed to successively remove successive tectonic events by interpret shallow horizon and restore it, to reveal structural model and seismic at the time of deposition. Here are the steps for the workflow (Figure 2):

（1） Interpret a top horizon (with contemporaneous faults) and a bottom horizon
（2） Use this two (top and bottom) horizons to build a structural model
（3） Restore the structural model at the time of deposition
（4） Restore original seismic data at the depositional time stage
（5） Use new restored seismic to interpret second horizons and faults
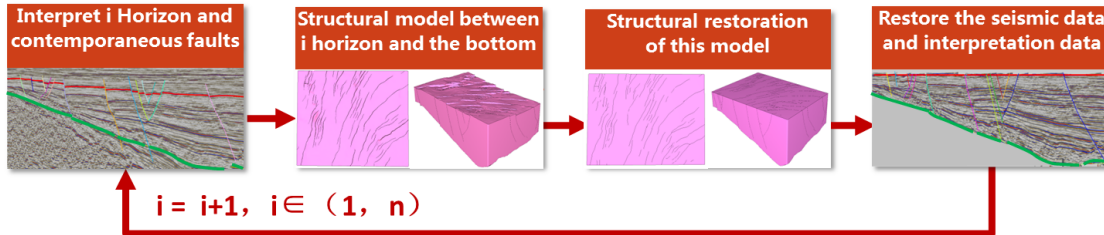

Figure 2

（6） Make a backward restoration for interpretation from geologic time to today (Figure 3)
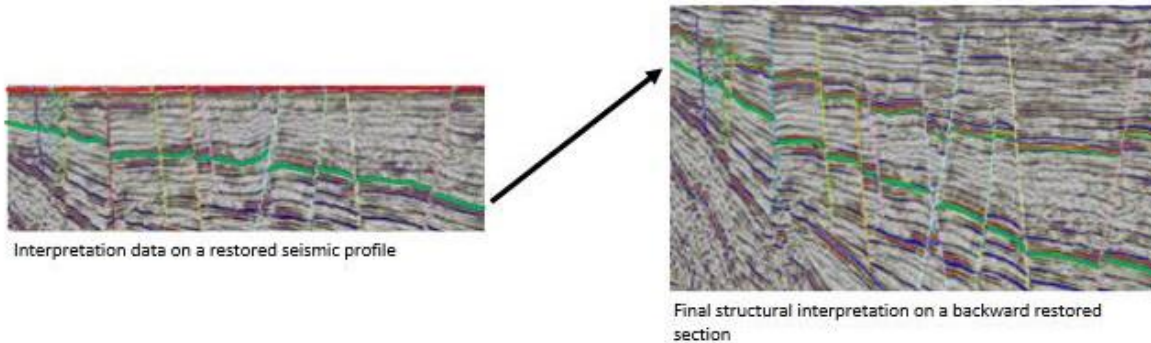

Figure 3

Examples

In this case (Figure 4), we interpreted top (in pink) horizon with contemporaneous faults and bottom (green) horizon to create structure model and restored it in its paleo position. The restoration process also restores seismic volume and interpretation data into pre-fault conditions. It helps in eliminating influence of corresponding tectonic movement and also interprets intermediate (in yellow) horizon (Figure 5).
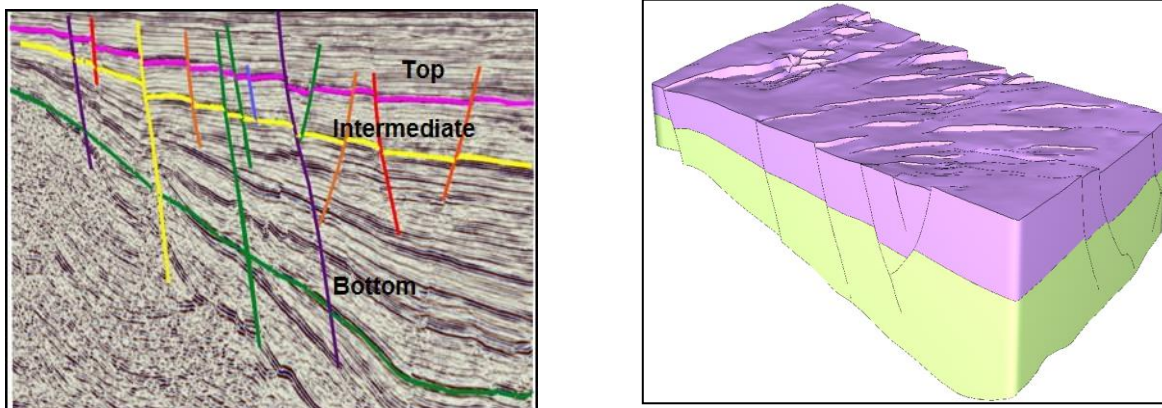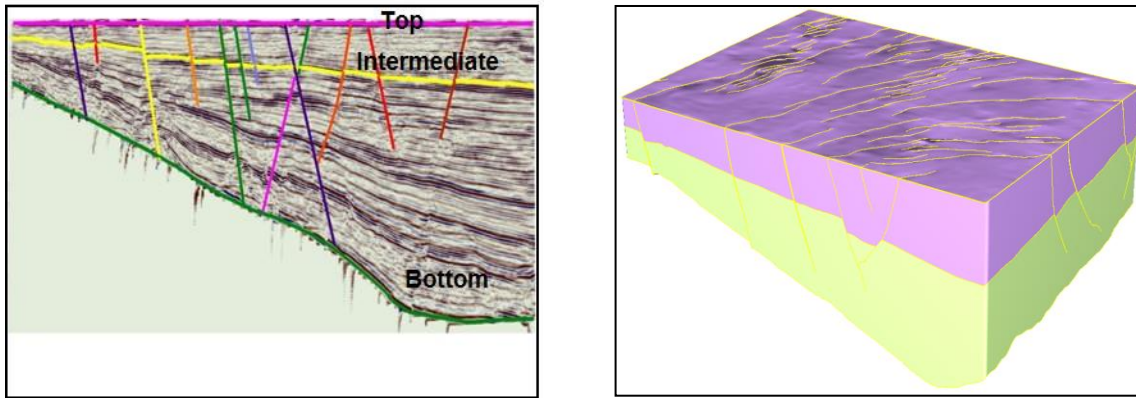

Figure 4

Figure 5

Advantages

Simplification. By using this approach of interpretation, structural restoration iteration (I+1) eliminates the influence of corresponding tectonic movement and take one tectonic movement into consideration at a time instead of multistage events. The restored seismic makes it easier to pick horizons and to identify the various stages of fault development.

Efficiency. The proposed workflow accomplishes interpretation, modeling, and structural restoration simultaneously to obtain accurate results in a very short period of time.

High quality. Seismic data may be of a poor quality in complex structural areas which undergone multiple tectonic events. However, by applying this workflow one can achieve more conclusive interpretation by eliminating the influence of tectonic movements. All of the interpretation results in paleo times can be transformed back into present time.

Analysis. Paleo structural models can be integrated with well log data to build attribute or property model in its original deposition and can be used in reservoir analysis and basin simulation. Similarly, the restored seismic volumes and interpretation data can be used in seismic attributes extraction and seismic inversion.

Conclusions

This workflow can greatly reduce effort and time of seismic interpretation in structurally complexed areas, yet preserving uniqueness and integrity of interpreted data. Using this application can assist in building a more realistic interpretation of higher quality and efficiency.

Acknowledgements

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