PS Understanding the Deformation of the Naga Thrust Triangle Zone, NE India, Using Structural Modeling of 2D Seismic Data*

B. Michael¹, C. M. Burberry², P. Jaiswal¹, S. Rath³, S. N. Singh³, and G. Barali³

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¹Oklahoma State University, Stillwater, OK, USA (brandy.michael@okstate.edu)
²University of Nebraska-Lincoln, Lincoln, NE, USA
³Oil India Ltd., Noida, India

Abstract

Seismic interpretation of structures associated with complex zones can be tested for viability using multiple methods. Combined methods of multiscale waveform inversion and prestack depth migration provide a two-step process to describe large wavelength and small wavelength features in the same image. This provides a detailed base image for balanced reconstruction of a cross section. The processed seismic line created in this study was interpreted and restored to provide a mechanically feasible model for the Naga Thrust Triangle Zone (NTTZ).

2-D seismic data was acquired in the central part of the Naga Thrust and Fold Belt (NTFB) in NE India. The study area is approximately 20 kilometers southwest of the Digboi oil field. The initial 2-D seismic data was imaged with a combination of traveltime inversion and prestack depth migration (PSDM). An improved image was acquired from a combination of multiscale waveform inversion and PSDM. The seismic line was interpreted using images from all stages of the processing and was restored using line length and key bed balancing techniques.

The cross-section created indicates minor deformation above the Naga thrust, via a series of back-thrusts, with a shortening of around 5% in this hanging-wall block. Beneath the Naga Thrust, within the triangle zone, several thrust blocks are interpreted, creating an antiformal stack similar to classic triangle zone structures in the Alberta Foothills, Canada. Overall shortening across this region is around 40%.

Structural interpretation in this study area provides insight into the geologic history, continued structural deformation and future hydrocarbon exploration of this region. Further study of migration and maturation may prove the potential of petroleum systems in sub-thrust features of the NTTZ. Large sub-thrust traps beneath the Naga Thrust are possible as shown in this restored cross section. This study provides insight into the use of traditional and non-traditional geological processing methods in combination with traditional structural methods. This inter-disciplinary approach can provide transformative insight for interpretation of previously constructed models.
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Michael, B. 1, Burbury, C.M. 2, Jaiswal, P. 1, Rath, S. 2, Singh, S. N. 2, Barali, G. 3

*brandy.michael@okstate.edu, 1Oklahoma State University, 2University of Nebraska-Lincoln, 3Oil India Ltd.

1. Introduction

Seismic interpretation of structures associated with complex zones can be tested for viability using multiple methods. Combined methods of multiscale waveform inversion and prestack depth migration provide a new step process to describe large wavelength and small wavelength features in the same image. This provides a detailed base image for balanced reconstruction of a cross section. The processed seismic line created in the study was interpreted and combined to provide a mechanically feasible model for the Naga Thrust Triangle Zone (NTZ). The seismic line was interpreted using images from all stages of the processing line including using flat length and key bed balancing techniques. Literature and well data confirm detachment in the Barail Group in the Upper Barail group led to investigation of other possible decollement surfaces and structural geometries.

2. Geological Setting

- NW verging, NE striking Naga Thrust and fold Belt (NTFB) bounded Himalayas in Northeast India
- 2D seismic data acquired in central Himalayas in Northeast India and Fold Belt (NTFB) foothills of NW Himalayas
- Upper Barail Group and Jaintia Group
- Mechanically, potential detachment surfaces occur within Upper Barail Group and Jaintia Group
- Barali and Jaintia formations are considered regional petroleum source
- Tipam Sandstone formation behaves as coherent unit

3. Seismic Processing

- Image obtained by a combination of multi-scale waveform inversion and Pre-stack Depth Migration (PSDM) (Figure 4)
- Waveform inversion provides a physical property map of selected region of seismic image, close to the Naga Thrust
- Combined images provide more detailed structural features related to the Naga Thrust fault
- Perturbations from the final waveform inversion model were overlain on the seismic depth image (Figure 4), resulting in a good correlation with the formation tops from an exploration well (Figure 4)
- Seismic well markers indicate G = Girujan, UMI = Upper Middle and Lower Tipam Formations (Figure 4)
- Combination of Figure 4 with the larger PSM image in Figure 5 used for Structural modeling

4. Structural Modeling

Interpretation 1

- Thickening of Barail Group toward Southeast
- Consistent Decollement (Upper Barail) hinderland to foreland
- Backbone geometry
- Key Bed Tipam Sandstone
- No pre-existing structures

Interpretation 2

- Consistent Thickness of Barail Group
- Step-up in Decollement hinderland (Jaintia) to foreland (Upper Barail)
- Stacked thrust geometry in subthrust
- Key Bed Tipam Sandstone
- Pre-existing extensional faults

5. Conclusion

- Both of these interpretations are mechanically viable in restoration.
- Initial modeling of Interpretation 1, based on detachment in the Upper Barail, resulted in thickening toward the Southeast which is not supported by literature.
- Interpretation 2 significantly changed the subthrust geometry and interpretation of the detachment surface for the Naga Thrust and Fold Belt while remaining consistent to literature and well data.
- Interpretation 2 mechanically restores pre-existing extensional faults from tectonic activity affecting compressional structures suggested from literature.
- Interpretation 2 most likely represents the deformation history of the Naga Thrust and Fold Belt.
- Structural interpretation in this study areas provides insight into the geologic history, continued structural deformation and future hydrocarbon exploration of the region.
- This study provides insight into the use of traditional and non-traditional geological processing methods in combination with traditional structural methods, which can provide transformative insight for interpretation of previously studied data.

6. Acknowledgements & References

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