Seismic Modeling, Migration and Velocity Inversion Bituni Bay

Bee Bednar

Panorama Technologies, Inc. 14811 St Marys Lane, Suite 150 Houston TX 77079

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Outline

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Bituni Bay (Shurter. et. al TLE 2009)

Objectives and Approach

- Help understand key subsurface components
 - Adverse affect on seismic data and image quality
 - Particularly in clastic reservoirs below thick and karstified carbonates

Four main steps

- Creation of realistic geologic models based on seismic interpretations
 - Two models were created to test alternative hypotheses
- Creation of 3D velocity and density models based on geologic models
- Generation of 3D FD shot records with dense, areal receiver grids
- Depth migrations of various acquisition geometries and samplings



Bituni Bay Case Study (Shurter, et. al TLE 2009)



The Verwatta field is located approximately 3200 km East of Jakarta in Bituni Bay. Key subsurface features include: thick massive lime stones (Kais and Faumai), karsting, stratigraphically complex reservoir (Paleocene channe sands) and shallow gas sands (in Steenkool-Klasafet).

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Bituni Bay Case Study (Shurter, et. al TLE 2009)



Geologic cross section showing that key subsurface features include: thick massive lime stones (Kais and Faumai), karsting, stratigraphically complex reservoir (Paleocene channel sands) and shallow gas sands (in Steenkool-Klasafet).

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Bituni Bay Case Study (Shurter, et. al TLE 2009)



(a) Shallow gas accumulations are based on high-amplitude seismic reflectors in the Steenkool-Klasafet. (b)Shallow gas accumulations are included in the subsurface geological model.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

(a) Coherency slice at Faumai zone from OBC seismic data, karst feature represented in black. (b) Inferred horizons representing karstified zone.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Channel model in Paleocene interval: (a) mud prone, (b) upper member (c) mud prone, (b) upper member (c) mud prone, (c) upper member.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Time slice of migrated synthetic volume (a) and cross section in Y direction resulting from narrow-azimuth acquisition geometry (b) Red arrow points to area of interest.

Bituni Bay Case Study (Shurter, et. al TLE 2009)

Time slice of migrated synthetic volume (a) and cross section in Y direction resulting from wide-azimuth acquisition geometry (b). Red arrow points to area of interest, better signal-to-noise ratio and good reflector continuity.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

(a) Three KM cable

(b) Five KM cable

Comparison of inline 1486 from both NAZ geometry volumes, showing that the quality of both images is similar.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Inline 1486 from the densest WAZ acquisition geometry volume. Image quality is considerably improved over the same line from the NAZ volumes.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

A typical inline comparison from the NAZ and WAZ150 volumes (Model 1) running north-south from an area of dense karsting and shallow gas presence in the north, to a relatively karst- and shallow gas-free area in the south. The image beneath the karsting on both lines is significantly degraded compared to the areas without karsting. However, many subkarst reflections on the MAZ150 image retain continuity and are easily picked.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

A typical inline comparison from the NAZ and WAZ150 volumes (Model 2). Here the top of the carbonate (Kais) was moved shallower, and the interval between the Paleocene and the Permian was expanded proportionally. The degradation of the entire NAZ subsurface image is obvious when compared to the same line from Model 1. The degradation of the WAZ subsurface image is significantly less than that of the NAZ image.

Bituni Bay Case Study (Shurter, et. al TLE 2009)

Comparison of Model 1 WAZ acquisition geometries using inline 1486. Differences are much more subtle than the differences between the NAZ and the WAZ. Note receiver line (RLI) and receiver (RI) intervals.

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Comparison of Model 2 WAZ acquisition geometries using inline 1486. The degradation due to the shallower top of carbonate is clear, but variation in image quality between the WAZ volumes is not enormous at the target intervals. Note receiver line (RLI) and receiver (RI) intervals.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Comparison of the reflection strength of the Jurassic reservoir, which is modeled as a continuous sheet and of constant (100m) thickness. High and continuous reflection strength gives some indication that the surface is well illuminated. This appears to indicate that the WAZ acquisitions are capturing significantly more reflected energy from the pre-Tertiary section.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Comparison of a line taken from both the Verwatta Field WAZ and NAZ seismic data sets. The top reservoir (Jurassic) annotated on the figure is the key horizon for this field. The improvement in reservoir reflector quality in the WAZ seismic data was sufficient in the Verwatta case to help the interpreterment directly pick the top reservoir for the first time in the field's history.

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Bituni Bay Case Study (Shurter, et. al TLE 2009)

Conclusions

- Key features affecting seismic imaging quality
 - Karsting
 - Depth of top of massive carbonates.
- Secondary features affecting seismic imaging quality
 - Shallow gas
- WAZ acquisition generally superior to NAZ
- Four fold increase in receiver line spacing resulted in relatively small changes in image quality
- Comparison of real NAZ and WAZ acquisition showed superiority of WAZ acquisition.

Questions?

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