Rejuvenating and merging multiple legacy 3D seismic datasets in the Krishna-Godavari Basin

Peter Lee, Subodh Notiyal, Amy Knowles, Rachel Collings, Jyoti Kumar, TGS*

Introduction

The Krishna–Godavari (KG) Basin is located on the east coast margin of India. The KG basin spans from onshore India into the deep-water offshore area with the Krishna and Godavari river systems discharging into the Bay of Bengal, forming one of the largest deltaic complexes in the region.

The KG Delta is a Late Cretaceous to Recent delta complex and forms the principal hydrocarbon exploration target in the area.
An area of 21,340 km^2 was identified covered by eleven multi-vintage marine seismic acquisitions, acquired between 2004 and 2021, Figure 1.

The datasets were reprocessed from field data using latest processing technologies incorporating machine learning deghosting, 3D demultiple, elastic Full Waveform Inversion (eFWI) and pre-stack anisotropic depth migration

Matching and merging of the datasets was performed upfront in the processing sequence to produce a continuous 3D volume.

Method

The eleven multi-vintage seismic datasets were previously processed independently prior to 2015 and reprocessing the data from field tapes provides a basin-scale, consistent, broadband data volume. The processing flow can be broken into two key fundamental steps: pre-processing and imaging.

Pre-processing

Combining the individual surveys in the preprocessing stage into one contiguous volume mitigates against processing edge effects caused by acquisition survey boundaries, which limit the fully imaged area of the individual surveys, and produced a fully imaged dataset over a much larger area.

Producing a seamless 3D volume using multiple input datasets of varying acquisition configurations requires good wavelet phase and amplitude control. To accomplish this, we combined a generalized machine-learning deghost technique, with survey-specific adaptation, to remove the source and receiver ghosts prior to the designature and debubbling, offering better phase control early-on in the processing flow. This was then monitored in the demultiple and subsequent stages of the pre-processing sequence.

Imaging

During the imaging stage a detailed velocity model was built which is used to migrate the matched and merged data, derived in the pre-processing stage, into its correct subsurface position.

The initial velocity model was derived from the East Coast India 2D^{cubed} dataset, a project which built a contiguous 3D seismic dataset and velocity cube from vintage 2D data. The initial velocity model was used as input into eFWI which utilises compressional and shear wave velocity information, V_p and V_s respectively, to update the velocity model using an optimization cost function. Incorporating both Vp and Vs information into the inversion derives a more accurate velocity model than V_p alone.

Wells were distributed over the project area and after screening and selection provided a regular distribution of V_p and V_s information over the project area and were used to constrain the elastic parameters in the eFWI process.

Finally the pre-processed seismic data and derived velocity model were combined in the final anisotropic Kirchhoff depth migration

Conclusions

Combining multiple datasets through simultaneous processing from field data provides a consistent, high resolution, seamless dataset allowing for detailed interpretation on both a regional and local scale. We achieved this through processing from field data and employing latest technologies such as machine learning deghost and eFWI.

Acknowledgements

The authors wish to thank numerous colleagues at TGS for their support and guidance. We would also like to thank TGS multi-client for permission to share images.

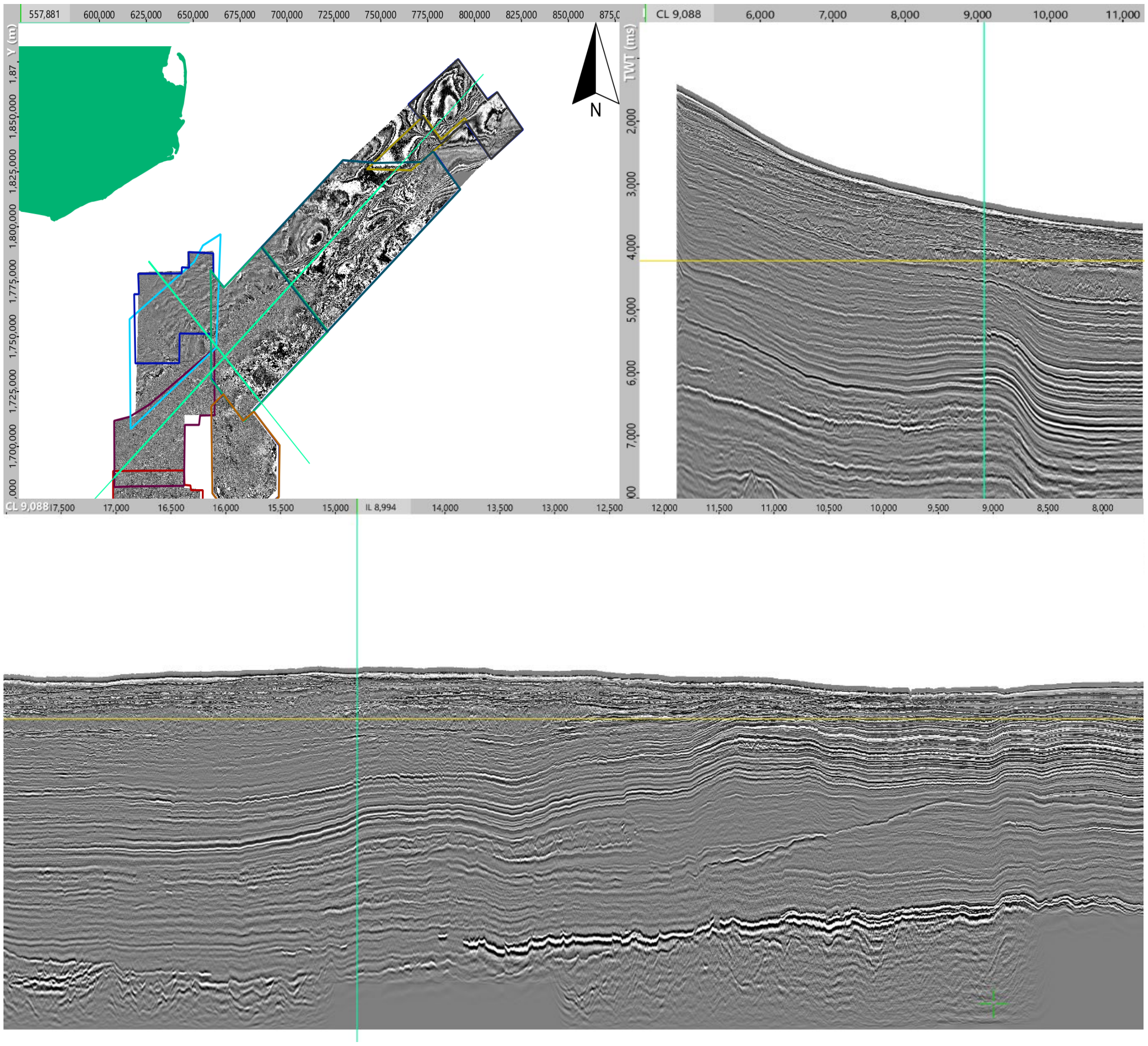

Figure 1 *– Timeslice (top left) with annotated legacy survey polygons; crossline (top right); and inline (bottom)*