Insights into subsurface geological characterization of Limerick Syncline using seismic and petrophysics

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Highlights

- ✓ Use of the seismic reflection method and petrophysical data for subsurface geological characterization;
- ✓ Insights into deep structures through seismic imaging and seismic interpretation;
- ✓ Petrophysical analysis;
- ✓ Data integration.

Limerick Basin Zn-Pb Deposits

The Limerick Basin hosts important Zn-Pb deposits like Pallas Green and Stonepark, yet major gaps remain in the understanding of deep structures, and the relation between magmatism and base metal mineralization. Insights on seismic imaging and geophysical inversions using petrophysics as constrains have the potential to provide key knowledge to fill some of these gaps.

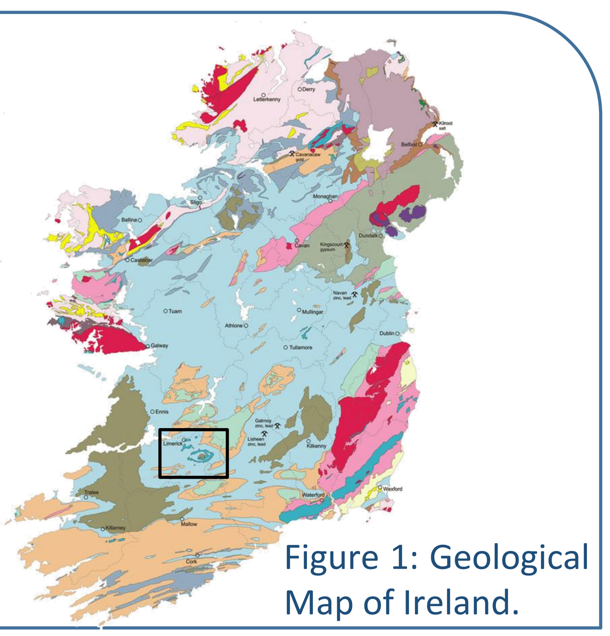


Figure 1: Geological Map of Ireland.

Ongoing Research

Data:

- Seismic reflection lines;
- Downhole petrophysics;
- Laboratory petrophysical data.

Subsurface Characterization:

- Velocity analysis using sonic logs to better characterize acoustic properties of each formation present in the Limerick Syncline;
- Seismic interpretation of deep structures and upper and lower boundaries of formations;
- Geology and petrophysics-guided depth velocity model building and pre-stack depth migration aiming to reduce interpretation uncertainties;

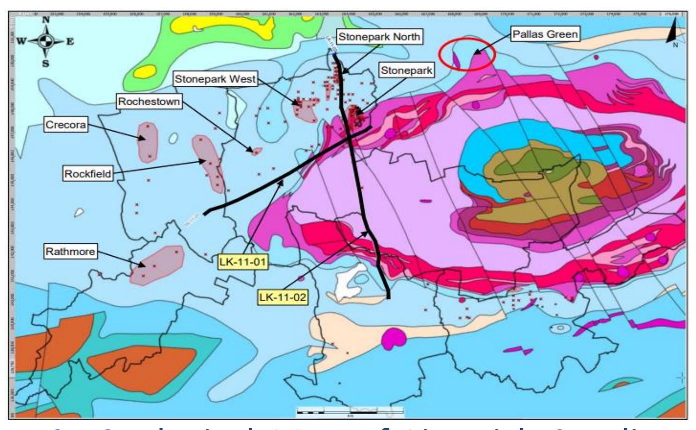


Figure 2: Geological Map of Limerick Syncline with prospects, seismic lines and borehole locations.

Petrophysical Data

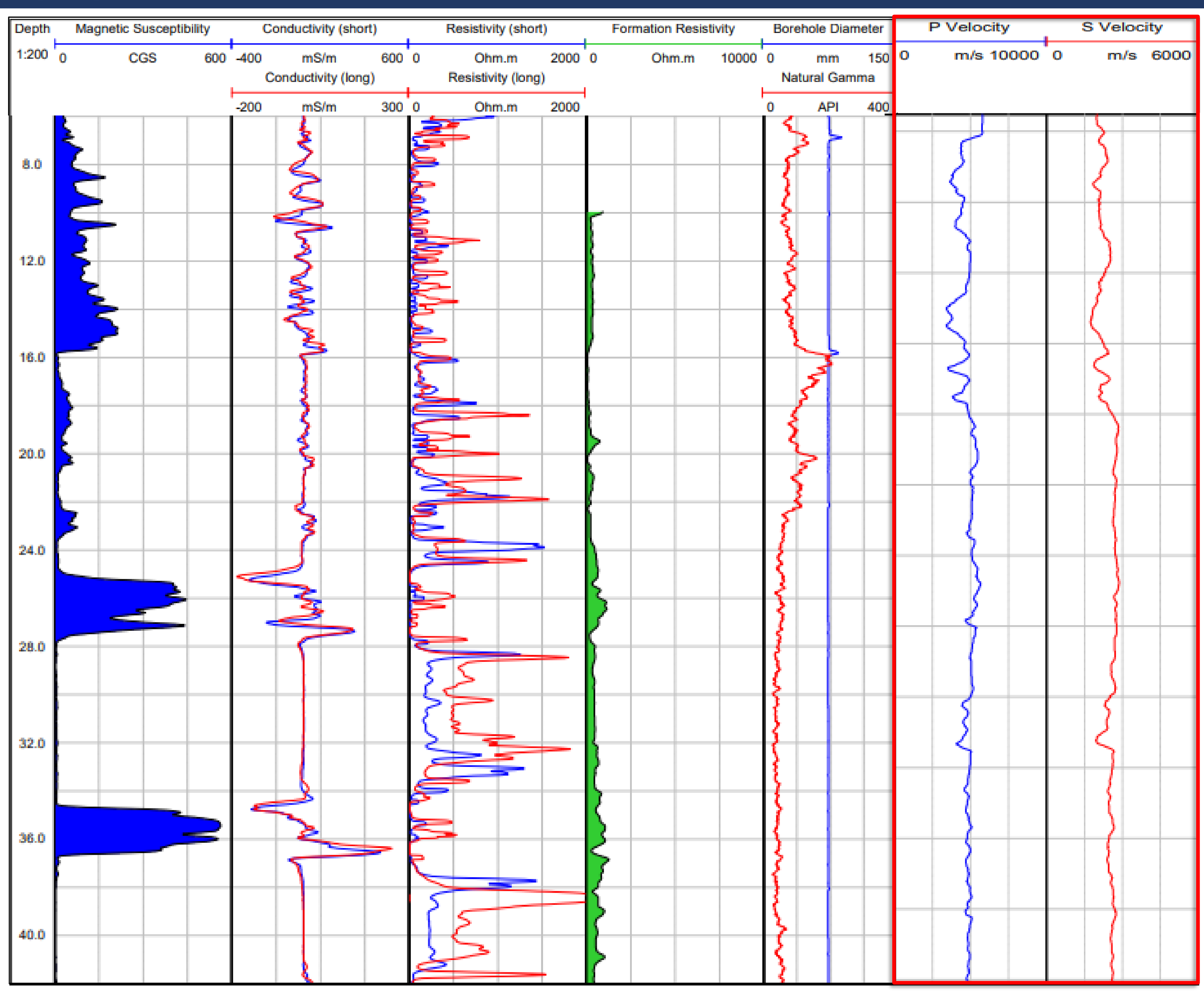
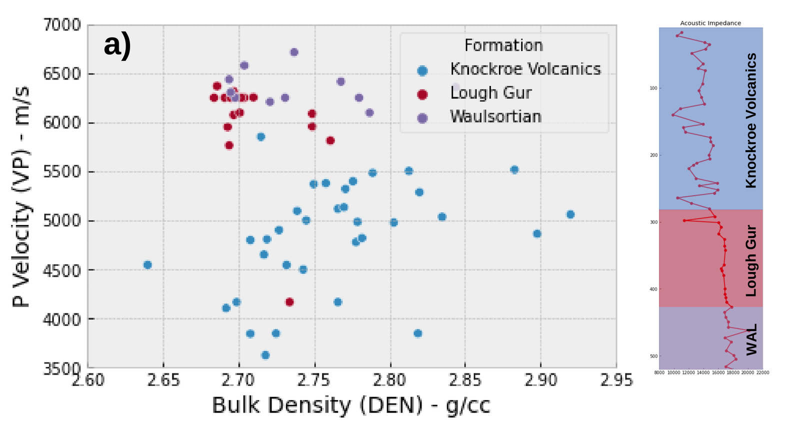
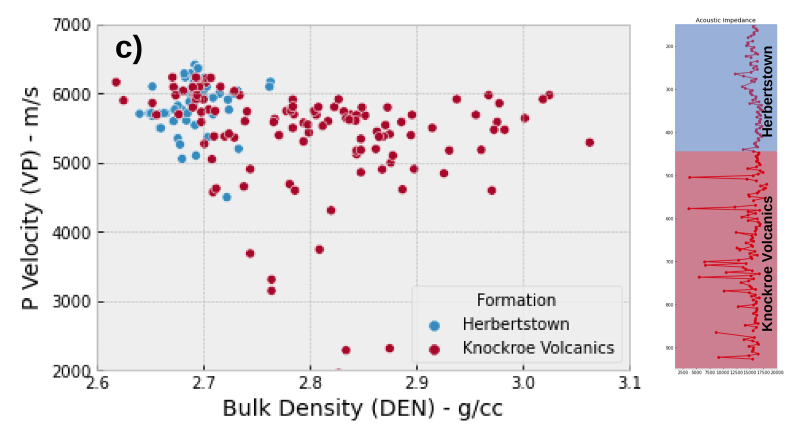


Figure 3: Data acquire by downhole petrophysics for borehole G11-2531-01. Magnetic susceptibility, conductivity, resistivity, formation resistivity and gamma are used to characterize the formations according to its physical properties. Sonic logs are highlighted due to the importance of its application for the new velocity model for geological subsurface characterization.





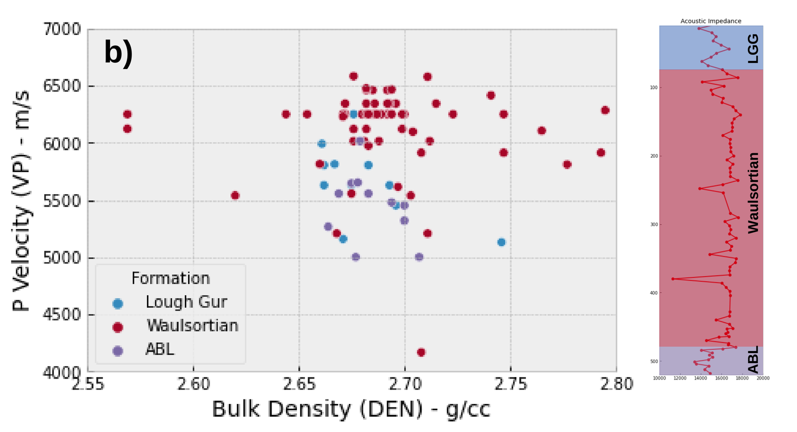
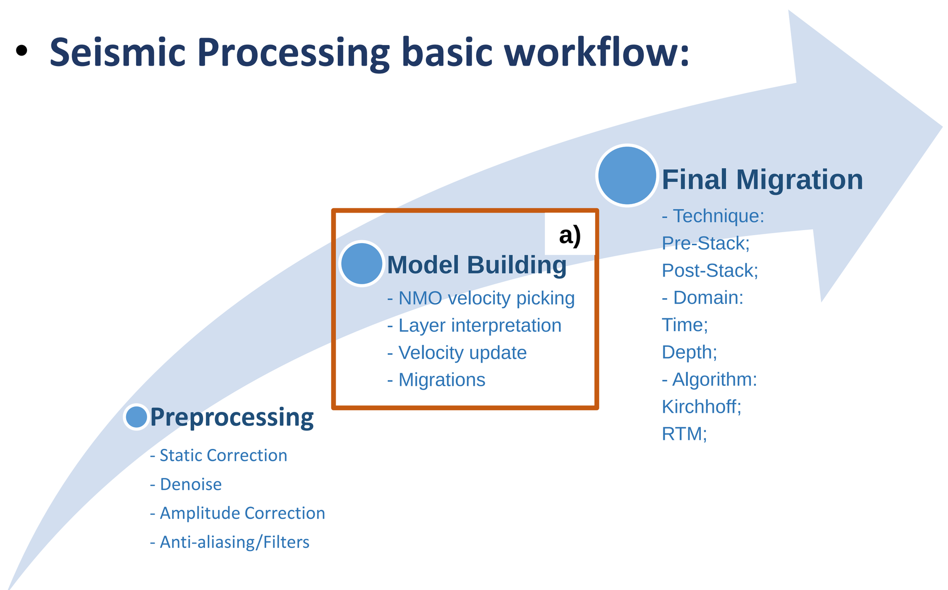


Figure 4: Cross-plot of P velocity vs. density for boreholes a) G11-2531-01, b) G11-2638-06 and c) TC-2531-001. Knockroe Volcanics show different velocity ranges for boreholes a) and c); in the borehole c) the Formation occurs in greater depths. This can also be observed in Lough Gur Formation (LGG). Waulsortian (WAL) shows variable values for both velocity and density due to different textures and poretypes, e.g. massive, brecciated, dolomitized, mineralized.

Seismic Data

- **Seismic Processing basic workflow:**



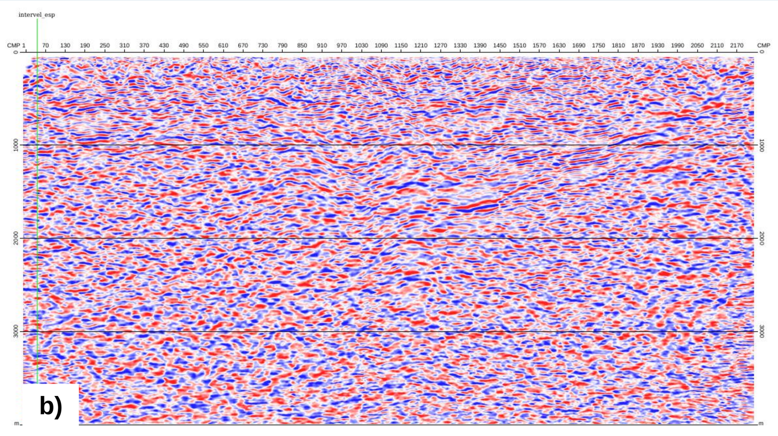


Figure 5: a) Seismic processing workflow highlighting the main challenge of the ongoing work. b) Example of final pre-stack depth migration.

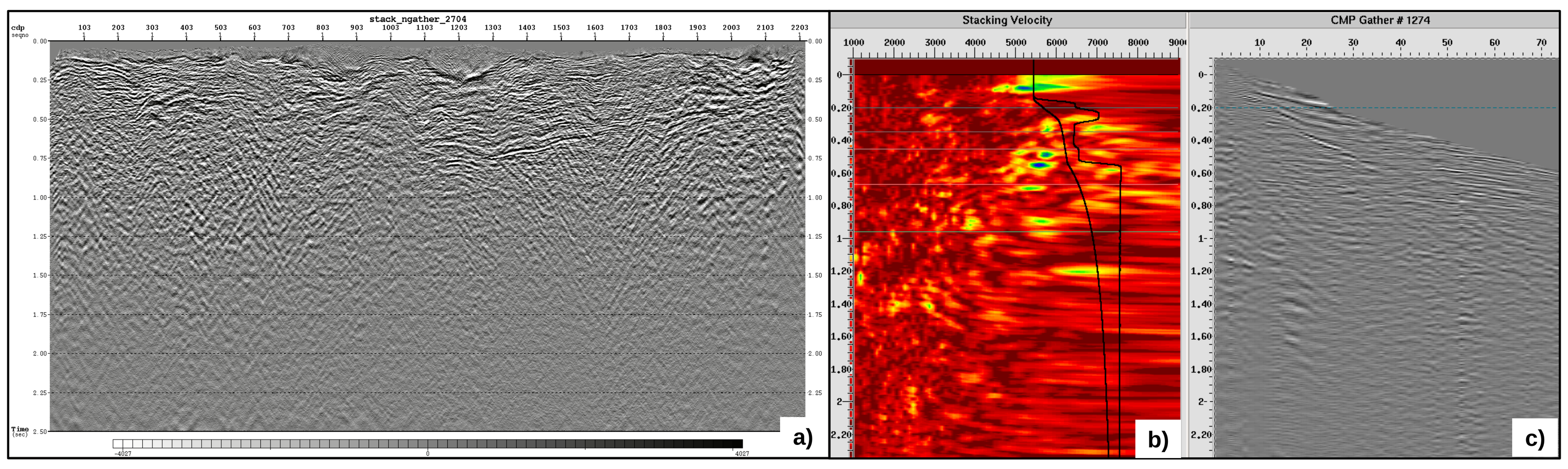


Figure 6: a) NMO corrected raw stack section using stacking velocity extracted from semblance velocity analysis. b) Semblance picking window for stacking velocity building. c) CMP gather.

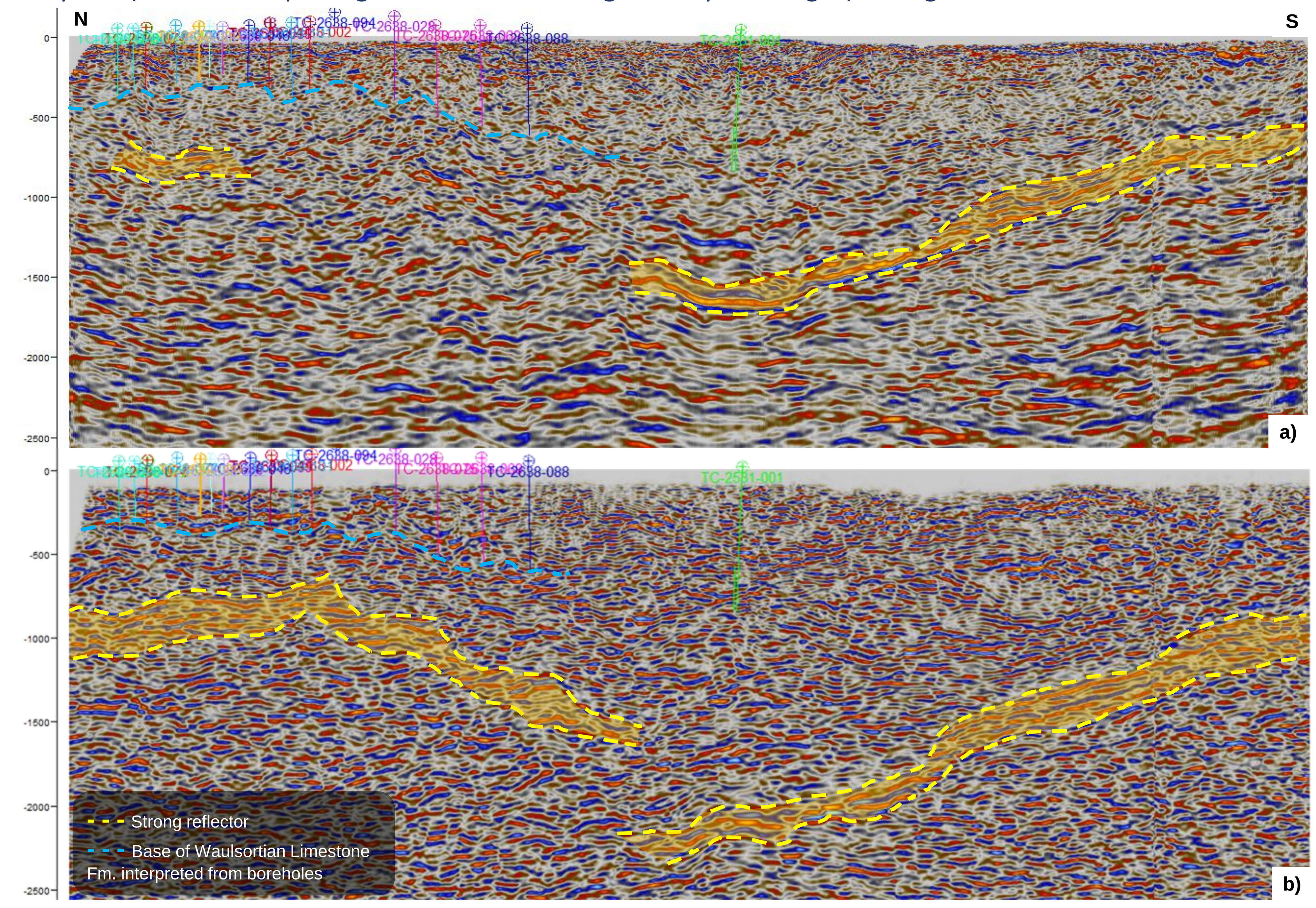


Figure 7: a) Depth section from previous reprocessing (2018) and boreholes across seismic line. b) New depth section migrated using updated interval velocity model guided by petrophysical data.

Future Work

Seismic data:

- Petrophysical data acquisition over samples from boreholes crossing the N-S seismic line for better understanding of lateral velocity variations;
- Time-depth conversion and reinterpretation of all available time seismic sections;
- Integration of all seismic interpretation and drillholes;
- Reinterpretation of structures and formation thickness in the Limerick Syncline;
- 3D geological model based on seismic interpretation and formation tops.

Geophysical inversions:

- Inversion of available gravimetric and magnetic data;
- Integration with previous results from seismic data.

References

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