Benefits of Utilising a State of the Art Software Product for Processing & Interpreting Seismic Shallow Water Data Sets

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Abstract

Background: The integration of GIS functionality into next generation seismic data processing, interpretation and reporting software products means that geophysicists can fuse existing sensor data sets (bathymetry, side-scan, magnetometer, video etc.) to aid the shallow water seismic data interpretation process. The presence of a GIS integrated with an intuitive, full-featured, powerful software application means that seismic data sets can be processed and interpreted faster and more accurately than ever before. An experienced freelance geophysicist's investigation and comparison of two Coda software products is presented below.

Results: Independent comparisons between using Survey Engine® Seismic+ and CodaOctopus® GeoSurvey GeoKit Seismic on the Applied Acoustics Wellington Common Data Set show that the former product offers significant benefits across the following areas: Productivity; Work Flow; Accuracy and Ease of Use.

Conclusion: A quantitative analysis of benefits of Coda Survey Engine Seismic+ demonstrates that this product offers significant productivity and accuracy improvements over Coda Octopus' existing seismic processing product, GeoSurvey GeoKit Seismic.

Introduction

Coda Octopus has been developing geophysical visualisation, processing and interpretation products since 1994. The Coda DA top end acquisition system running Coda GeoSurvey revolutionised the way that seismic and side- scan surveys were undertaken in the mid-1990s, resulting in huge productivity benefits when compared to the old traditional method of combining analogue sensors and thermal printers. To date, over 900 Coda GeoSurvey licenses have been sold. In the autumn of 2008 Coda Octopus embarked on an ambitious new product line development to revolutionise the way in which geophysicists perform their job once again and achieve very significant productivity improvements. The name of this new product family is Coda Survey Engine and the first product launched in July 2010 is named Coda Survey Engine Seismic+. To date, approximately 100 Coda Survey Engine Seismic+ licences have been sold.

The Applied Acoustics seismic common data set of Wellington Harbour presents an excellent opportunity to independently and quantitatively compare the processing and interpretation of this small data set using both Coda Survey Engine Seismic+ and Coda GeoSurvey.

Images produced using both products are available in Appendix A and Appendix B.

Methods and Resources

It is imperative in a comparison of this kind that all precautions must be taken to ensure that it is conducted in an independent, fair and transparent manner. There must be no bias and the chosen methodology must not implicitly disadvantage either product.

To fulfil these requirements, Coda Octopus contracted a freelance geophysicist who possesses a great experience of both products to process and interpret the data set. The processing of the lines was switched alternatively between the two products in order to try and ensure that familiarity with the geology didn't adversely skew the results to one particular product. When processing commenced, the first batch of lines processed was performed with Coda Survey Engine Seismic+.

The software packages used in the comparison are:

- Coda Survey Engine Seismic+ version 2.5.0
- Coda GeoSurvey version 5.2.0

The specification of the PC used in the comparison is displayed in Table 1.

Component	Specification
CPU	Intel core i5 3.3 GHz
RAM	8 GB DDR
Data Storage	256GB Solid State Disk – system disk 600GB 10,000 RPM – data disk 2 TB RAID SATA 2 – for data backups
Graphics	ATI HHD4550 512 MB DDR3
Operating System	Windows 7 Professional 64 Bit

Table 1: PC Specification

The database utilised for Coda Survey Engine Seismic+ was the default that ships with the product namely Microsoft SQL Server 2008 – Express Edition.

The data inputs used for the comparison were:

- Applied Acoustics Seismic Common Data set – series of multi-channel CODA format files acquired using a CODA DA 2000 acquisition system in conjunction with Applied Acoustics' boomer and sparker systems
- A PDF of the survey site detailing survey line positions
- A spreadsheet detailing online acquisition information.

For the purposes of this comparison, let us define the data processing life cycle as the process that takes one from raw seismic data files to a set of interpreted features that are suitable for importing into a charting package. The horizons that were chosen for interpretation were those that are consistent across all data files and clearly visible.

The data processing life cycle can be broken down into five workflow tasks, namely:

1. Data Preparation - organising and applying any adjustments to the data set and including the data import process
2. Interpretation Setup - the process of identifying horizons and features to interpret and configuring these in the software packages. For this comparison four horizons were identified and used – three for the sediments and one used for acoustic blanking
3. Seabed Tracking – the process of tracking the seabed position using a combination of manual and automated techniques. None of the data files had a valid seabed position embedded so all files had to be tracked
4. Data Processing and Interpretation – applying processing functions and interpreting the data features
5. Data Reporting – the setup and generation of custom ASCII reports for all interpreted features

Product specific notes on the method employed were compiled and presented in Table 2.

	Coda Survey Engine Seismic+	Coda GeoSurvey
Data Preparation	All files were batch selected and imported in a single operation using a WGS85. Due to the absence of heading in the original files, a course made good was calculated on import. All files successfully imported and displayed in the GIS view. Figure 4 illustrates this well.	GeoSurvey suffers the significant disadvantage of not displaying the Geographic overview of the seismic survey site. In order to create a workaround for this, fix marks were generated and processed data recorded to produce a unique set of fix marks per file. A report was created for every fix mark position and this was imported into Golden Software Grapher 7 to give a digital and paper copy of the created tracks.
Interpretation Setup	The default Interpretation Types were customised by editing the existing horizon and adding three further horizons. The sub- bottom sound velocity was set to 1650 m/s in all cases.	The horizons were added to the Tag Setup dialog and also added to the fast tags dialog.
Seabed Tracking	For each file, the seabed tracking was carried out by using the Auto-seabed Tracking tool using a thresholding algorithm. The mouse wheel was used to change the sensitivity until the best fit track was established. The seabed was then Auto- tracked for the whole line by a single right click of the mouse. The	A two-pass play through of the file is necessary to achieve total accurate coverage. On the first pass, the Auto-tracking thresholding algorithm was utilised using a playback speed of 70 pings per second to allow minimum disruption when the seabed tracking loses lock and allowing the user time to

	line can be quickly reviewed for accuracy using the scroll bar or auto-scroll modes. On the rare occasion where the Auto-tracking lost lock this could be quickly corrected by scroll-dragging the window to the required location, modifying the sensitivity using the middle mouse wheel and left clicking the mouse on the affected areas. For the very few areas of excessive noise on the data set, the manual seabed tracking option was employed.	reset the bottom position. On the second pass, the seabed position is reviewed and, where necessary, corrected using the manual seabed option.
Processing and Interpretation	Time Varying Gain, low and high pass filters were employed to enhance the data set and these settings were saved so that they would apply to subsequent lines. Features were interpreted and data scrolled using the middle mouse option to pan the data.	Similarly, Time Varying Gain and low and high pass filters were applied. Data was played back through at a fixed rate of 120 pings per second and manually paused while the interpretation was executed.
Reporting	All data lines were selected via the data explorer widow and the reporting option selected from the ribbon bar. The report wizard was configured to include the four horizons and the default fields were used to output the data.	The Report Setup option was customised from the default settings to report all the horizons and the Report Generation option was used to generate the report.

Table 2: Notes on Methodology

Results

The timings for both products are in Table 3.

	Coda Survey Engine Seismic+	Coda GeoSurvey
Data Preparation		
	00:02:00	00:22:11
Interpretation Setup		
	00:03:30	00:04:15
Seabed Tracking		
Seabed Tracking Total	00:16:25	00:55:15
LINE 002 SINGLE BOOM.COD	00:01:50	00:11:45
LINE 002 TRIPLE BOOM.COD	00:00:10	00:03:10
LINE 003 TRIPLE BOOM.COD	00:00:25	00:04:15
LINE 004 TRIPLE BOOM.COD	00:00:20	00:04:10

LINE 007 012 TRIPLE BOOM DUAL.COD	00:00:45	00:02:30
LINE 007 TRIPLE BOOM DUAL 02.COD	00:03:45	00:08:00
LINE 008 TRIPLE BOOM.COD	00:00:50	00:02:10
LINE 009 TRIPLE BOOM.COD	00:00:30	00:03:35
LINE 013 TRIPLE BOOM DUAL.COD	00:04:00	00:08:10
LINE 025 TRIPLE BOOM SINGLE.COD	00:02:40	00:03:35
LINE 031 TRIPLE BOOM SINGLE 02.COD	00:00:20	00:01:45
LINE 032 SINGLE BOOM.COD	00:00:10	00:00:30
LINE 033 SPARK 500 SINGLE 02.COD	00:00:40	00:01:40
Data Processing & Interpretation		
Data Processing and Interpretation Total	00:51:00	01:02:25
LINE 002 SINGLE BOOM.COD	00:03:32	00:03:05
LINE 002 TRIPLE BOOM.COD	00:02:55	00:02:50
LINE 003 TRIPLE BOOM.COD	00:02:20	00:01:40
LINE 004 TRIPLE BOOM.COD	00:02:28	00:01:50
LINE 007 012 TRIPLE BOOM DUAL.COD	00:01:45	00:04:10
LINE 007 TRIPLE BOOM DUAL 02.COD	00:09:45	00:22:55
LINE 008 TRIPLE BOOM.COD	00:01:30	00:01:55
LINE 009 TRIPLE BOOM.COD	00:00:50	00:01:05
LINE 013 TRIPLE BOOM DUAL.COD	00:13:00	00:08:45
LINE 025 TRIPLE BOOM SINGLE.COD	00:05:20	00:06:40
LINE 031 TRIPLE BOOM SINGLE 02.COD	00:03:20	00:02:45
LINE 032 SINGLE BOOM.COD	00:02:25	00:02:50
LINE 033 SPARK 500 SINGLE 02.COD	00:01:50	00:01:55
Data Reporting		
	00:00:54	00:02:11
Overall Total	01:12:49	02:26:17

Table 3: Timings for the Data Processing Life Cycle

Coda Survey Engine Seismic+ completed the data processing for this data set (1 hour 12 mins and 49 seconds) in less than half the time than it could be accomplished in Coda GeoSurvey (2 hours, 26 minutes and 17 seconds).

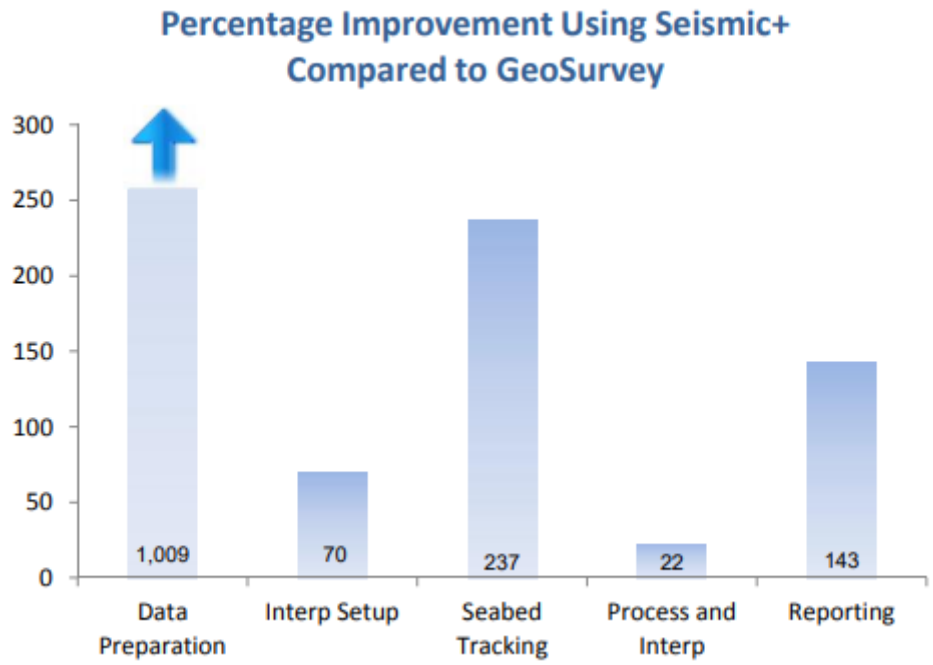

Figure 1: Percentage Improvement Using Seismic+

In all areas of the data processing cycle, Seismic+ shows significant improvement. Please refer to Figure 1 for details. In three areas Seismic+ shows more than 100% improvement. The more than tenfold improvement increase in Data Preparation is due to the fact that Seismic+ incorporates a GIS view of the data and thus no time is needed outside of the application to produce a map of the data lines. The seabed tracking algorithms and user interface have been refined resulting in a faster, more productive experience in tracking the seabed. Likewise, the reporting setup and generation has been streamlined in Seismic+.

The improvement in the speed of interpretation was not as great as the increases elsewhere. This is to be expected in part, since much of the time taken interpreting the data is spent with the geophysicist coming to his or her own conclusions about the data and so is not a function of the software. Seismic+ offers the geophysicist a number of tools in the GIS view and in the ability to compare interpretation on adjacent lines and cross-lines quickly, so an improvement is still seen. Please see Figure 4 and Figure 5 for details. We would expect this improvement to be greater in a larger, more structured dataset with regular cross-lines.

It is interesting to examine where time was spent per product. This is illustrated in Figure 2 and Figure 3.

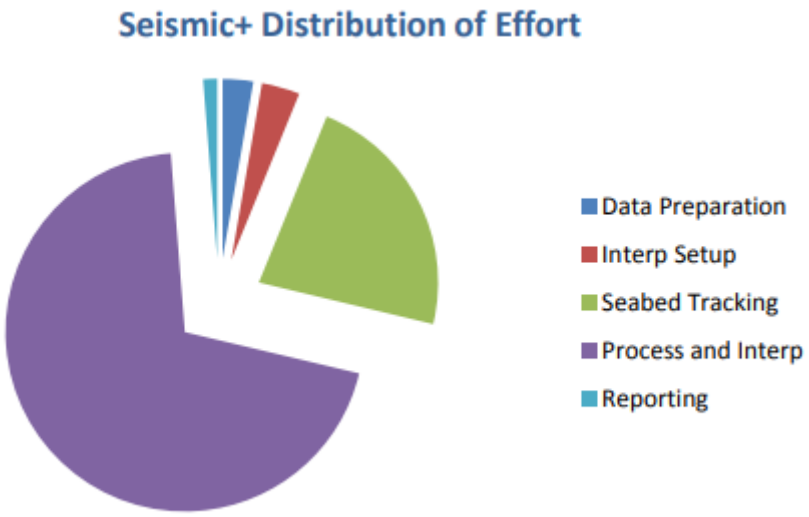

Figure 2: Seismic+ Distribution of Effort

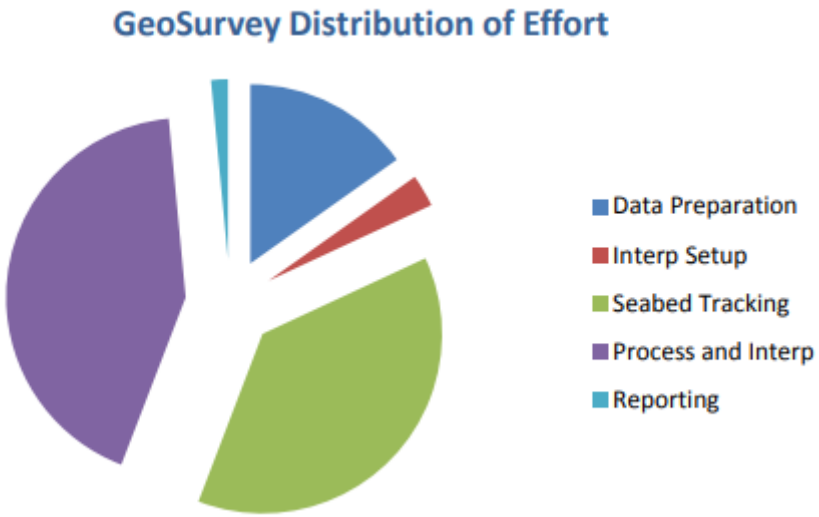

Figure 3: GeoSurvey Distribution of Effort

The majority of the time in Seismic+ was spent on the actual interpretation of the data. This is intuitively what one would expect. However, for Coda GeoSurvey, a comparative amount of time was spent in the seabed tracking phase. This area has been much improved in Seismic+.

In addition to the raw timings of each phase, the experienced freelance geophysicist was asked to note strengths and weaknesses for both products during each stage of the data processing life cycle. These are presented in Table 4.

	Coda Survey Engine Seismic+	Coda GeoSurvey
DATA PREPARATION		
Advantages	Data import is simple and efficient requiring little knowledge of how the source data is structured on disk. Data can be easily added to projects at a later time. The GIS window gives an immediate overview of the survey site and multiple geo-referenced raster and vector file formats (e.g. GeoTIFF and DXF) can be incorporated.	The ability to adjust any navigation value at any time. Ability to record processed data.
Disadvantages	There is currently no function to correct the navigation after import. However the functionality will be available in version 2.6.	GeoSurvey requires the user to remember where the files are stored, especially if the folder structure is more complex than the example data set. For instance, if a survey line is recorded over two days, these files may be stored in different folders and without good book keeping will be difficult to find. Alternative software packages have to be used to determine their location and relationship to others.
INTERPRETATION SETUP		
Advantages	One intuitive dialog to adjust feature types. User can select from all available features during interpretation phase. Ability to set different seismic velocities for each horizon to be used in the depth calculation.	None over Seismic+.
Disadvantages	Minor: the feature setup dialog is only accessible when a data window is open.	Two menus required to setup the horizon with an additional setting to setup the seismic velocity (one velocity for all horizons). Not all defined features can be displayed in a data window, limited to 12.
SEABED TRACKING		
Advantages	Very quick to set up and use. Easy to review the result before committing – multi-level undo feature. Very easy to adjust incorrect auto-tracked values by semi-automatic or manual correction.	Seabed track offset value.

	Ability to cope with noise in the water column.	
Disadvantages	Not possible to track negative returns. No seabed track offset value.	More time consuming due to increased user interaction to intervene when tracking loses lock. Requires a playback speed slow enough to suitably view the data and observe any mismatches. Any errors with bottom tracking cannot be undone.
DATA PROCESSING AND INTERPRETATION		
Advantages	Ability to easily customise data view, zoom and pan. Quick access to trace controls to allow the user to alter the amount of data viewed on screen. Comprehensive data processing menu which is very easy to manage. Ability to view multiple lines of data within the same window. Composite sections made up of intersecting and/or adjacent lines of data. Ability to view feature intersections on neighbouring lines within another window that can be updated in real time. Use of the GIS link option to see the current seismic window position within the GIS view in real time. Ability to compare difficult & complex geology in multiple windows. Ability to view other survey data such as bathymetry, magnetometer, core logs and other geological isopachyte charts in real time context.	Excellent imaging of the data. Good data filtering.
Disadvantages	None found.	No ability to compare associated data with multiple viewers without the use of external packages (time consuming). Not able to show points of intersections with other lines. Playback and review of data limited to the goto function and external referencing media (digital/paper plots etc.) Many menus to control data imaging.
DATA REPORTING		

Advantages	Simple wizard driven interface. Fast report generation. Ability to filter the spatial data within the report before exporting to chosen output format. Can remain within the same window to quickly export multiple horizons separately or all at the same time.	DXF output.
Disadvantages	No DXF output support currently – although this will be available in a future version.	Multiple menus required to export data. Unintuitive database ID needed to cross reference feature database to data files.

Table 4: Advantages and Disadvantages of Each Product

Conclusion

It has been demonstrated quantitatively that Coda Survey Engine Seismic+ offers major productivity improvements over Coda GeoSurvey processing a small shallow water data such as the common data set supplied by Applied Acoustics.

This increased productivity will result in a much shorter data processing period and costs for survey companies.

The benefits of Coda Survey Engine Seismic+ are not just limited to the raw productivity improvements. The product is much easier to use and does not require as much extensive training as Coda GeoSurvey. It benefits from excellent support and is being actively developed to expand the feature set. This year will see the integration of side-scan data into the Survey Engine product which will offer significant advantages in multi sensor surveys.

Acknowledgements

The authors would like to thank Chris Ferguson, Freelance Geophysicist for the analysis of the data set using both products. Chris has many years commercial experience with Coda GeoSurvey and latterly Coda Survey Engine Seismic+. He was also employed by Coda Octopus between July 2006 and August 2008 providing technical support, field support and training services to clients across the Coda Octopus product range.

We are also grateful to Applied Acoustics Engineering Ltd for the supply of the common data set.

Further Information

Coda Survey Engine Seismic+ - http://www.codaoctopus.com/coda-seismic-plus

Coda GeoSurvey - http://www.codaoctopus.com/coda-geosurvey

Appendix A – Coda Survey Engine Seismic+ Imagery

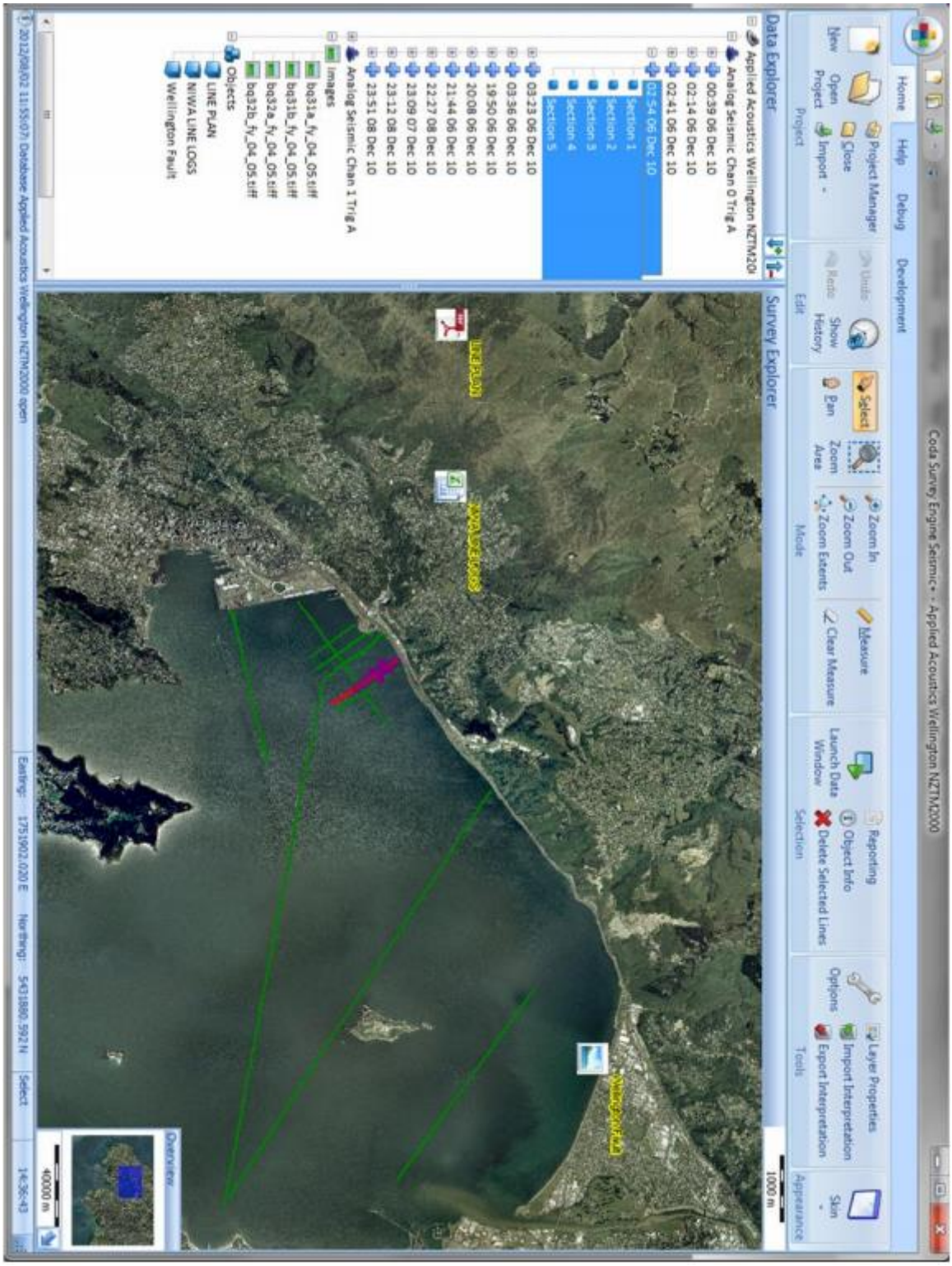

Figure 4: Coda Survey Engine Seismic+ Survey Explorer View. The line highlighted in red with purple overlay is Line 004 Triple Boom, the contents of which are displayed in Figure 5. Aerial imagery courtesy of Land Information New Zealand

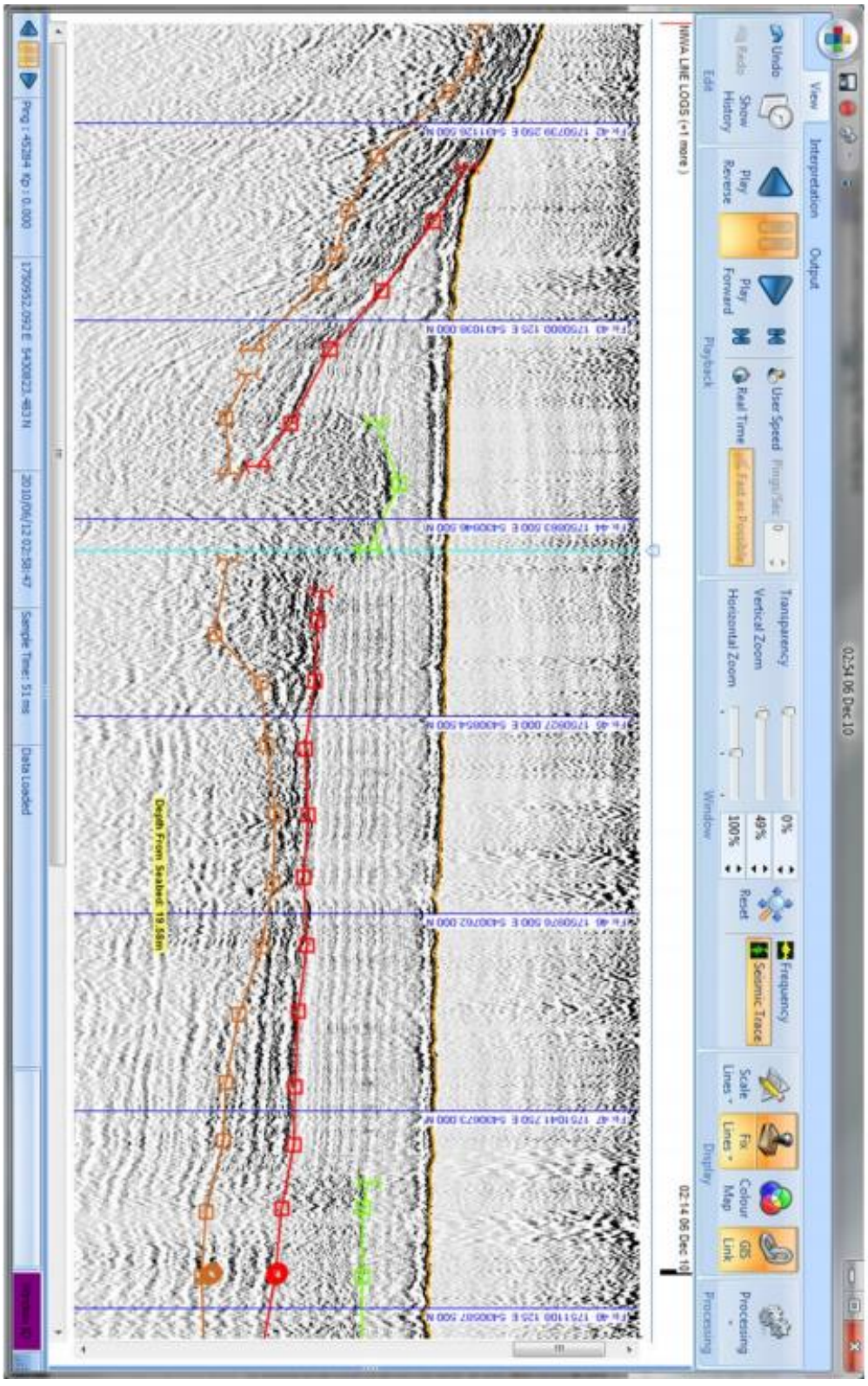

Figure 5: Seismic Window displaying Line 004 Triple Boom. Interpreted features shown, including horizon intersections from cross lines (circles). The 'X' displayed in Figure 4 is the position of the 'Ping Selector' in the Seismic window.

Appendix B – Coda GeoSurvey Imagery

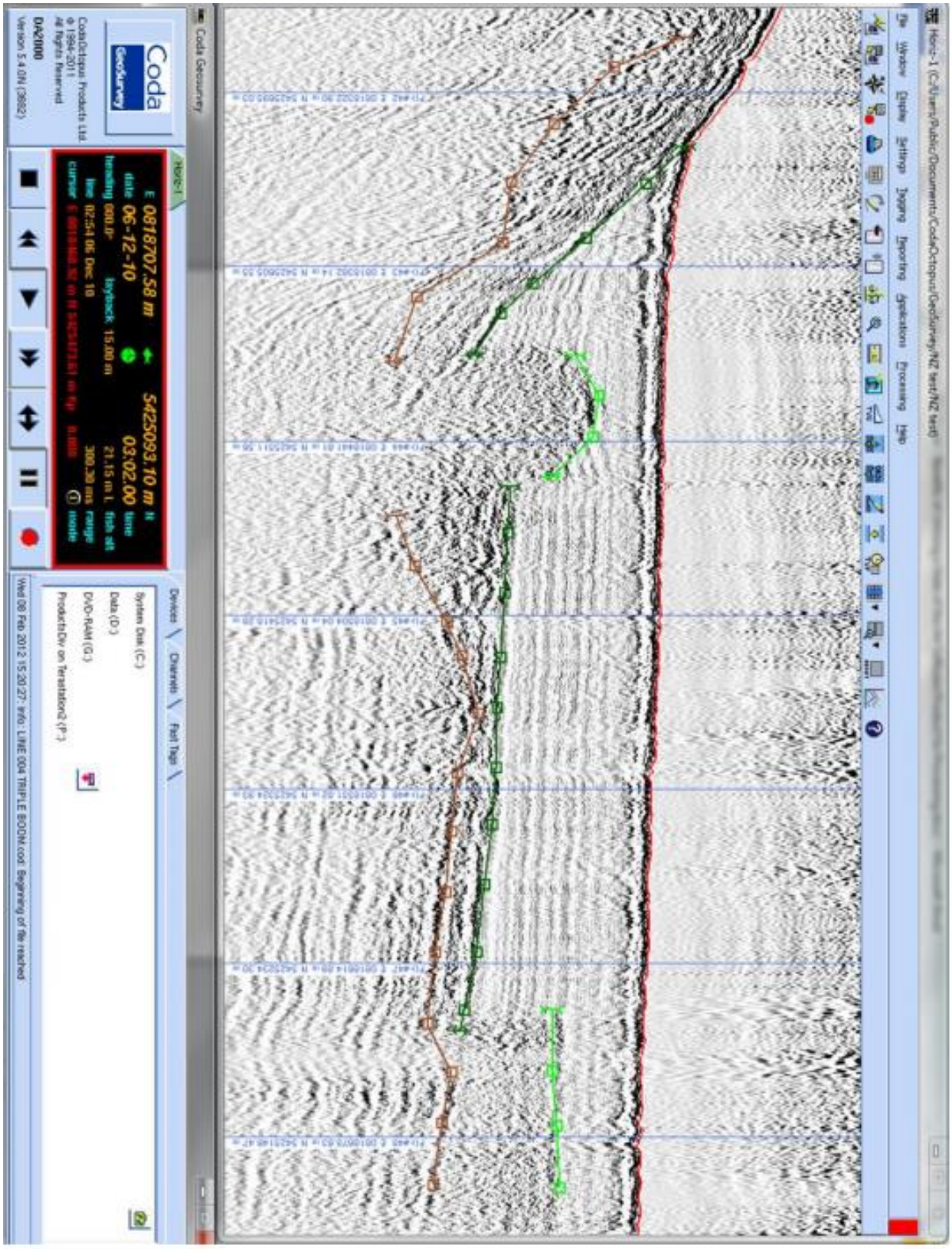

Figure 6: Coda GeoSurvey displaying Line 004 Triple Boom. Interpeted feature are displayed.