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Calculating & Correcting for Latency in Sub-bottom Profiling Data

By Peter Ramsay

Introduction

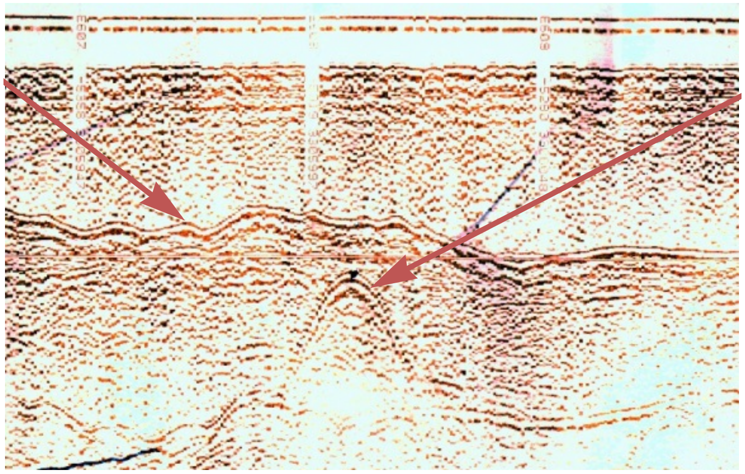
I have fielded quite a few questions recently from customers who are using sub-bottom profilers to determine the position and depth of burial of pipelines crossing rivers, and buried pipelines offshore. Sub-bottom profilers are an excellent choice of instrument to search for and map burial pipelines but one has to understand what buried pipelines look like in sub-bottom profiling data and how to apply corrections to the data to enable accurate targeting of the buried pipeline in X, Y & Z (position and depth of burial).

IMPORTANT: **Importance of Correct Hardware Setup & Compensating for Latency**: *To ensure that the positional data is correct in the sub-bottom data, it is imperative that the offsets between the DGPS and the sub-bottom profiler transducer are correctly measured and entered into the HARDWARE program and that the DGPS data is of good quality. Additionally, it is important to correct the sub-bottom profiling data during post-processing for latency which is the time delay between measurement and transmission to the data collection computer. If one does not correct for Latency, the position of sub-bottom profiling targets and reflectors will not be in the correct position. Latency corrections are less critical for reflectors but very important for precise targeting of buried objects*

What do Buried Pipelines Look Like in Sub-bottom Data

Buried pipelines are quite easy to detect in sub-bottom profiling data. The reflected sound waves from the buried pipeline contrast against the surrounding sediments due to differences in acoustic impedance and the pipeline is evident in the data as a diffraction hyperbola (Figure 1).

FIGURE 1. Boomer sub-bottom profile showing the diffraction hyperbola associated with a buried pipeline.



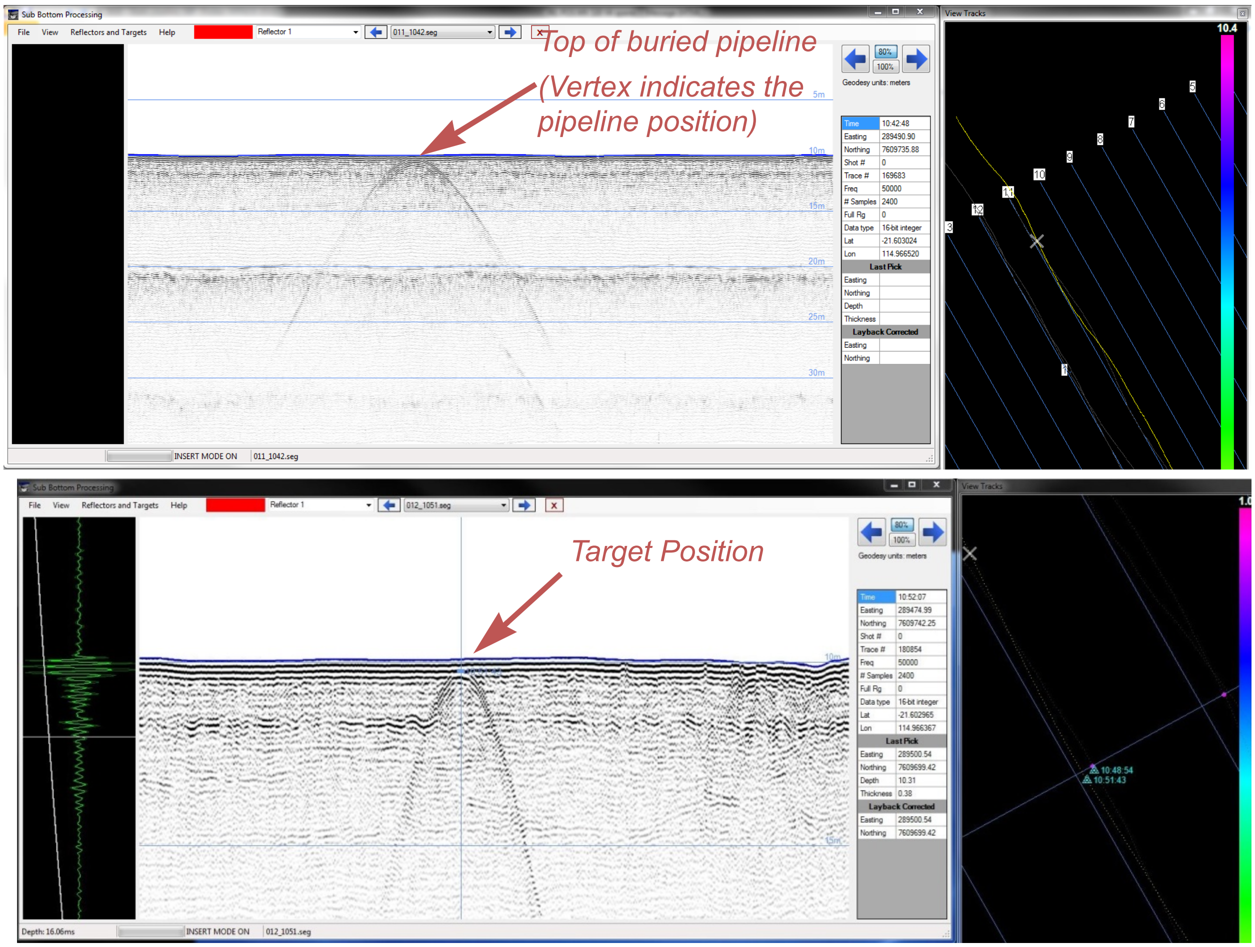
LATENCY CORRECTION IN SUB-BOTTOM DATA

If you have collected and processed single beam bathymetry data in HYPACK®, correcting for latency will be a familiar task. The survey line collection procedure is similar in that reciprocal pairs of lines are run perpendicular to the pipeline at a constant speed. It is recommended that 2-3 pairs of lines are surveyed over a pipeline or small object (buried or exposed) and then the latency values are averaged to obtain a best estimate of the latency in the survey system.

When using single beam bathymetry data there is a separate LATENCY TEST utility which is used to calculate the latency but within the SUB-BOTTOM PROCESSING program the process is more manual.

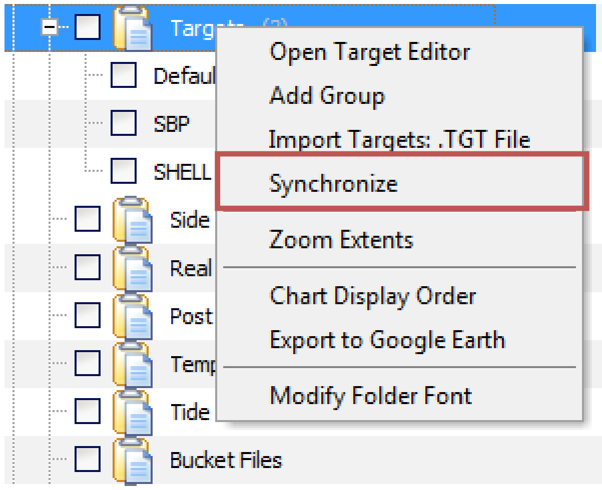
To determine latency in SUB-BOTTOM PROCESSING program you have to load the pairs of reciprocal lines in the program and apply band-pass filtering (for non-Chirp data) and TVG to obtain good quality data. Then locate the pipeline in the reciprocal data lines and use the zoom in x-direction and zoom in y-direction to “collapse” the pipeline hyperbola into a narrow V-shaped feature to allow the vertex of the hyperbola to be very accurately targeted (Figure 2). Use the mouse right-click to generate a target at the hyperbola vertex.

FIGURE 2. Pinger sub-bottom profiling data showing a shallow buried pipeline which appears as a hyperbola in the record (top image). Using the zoom function, the pipeline hyperbola can be “collapsed” into a narrow V-shape to determine the vertex position more accurately (bottom image). The targeted pipeline position is the vertex of the hyperbola (bottom image



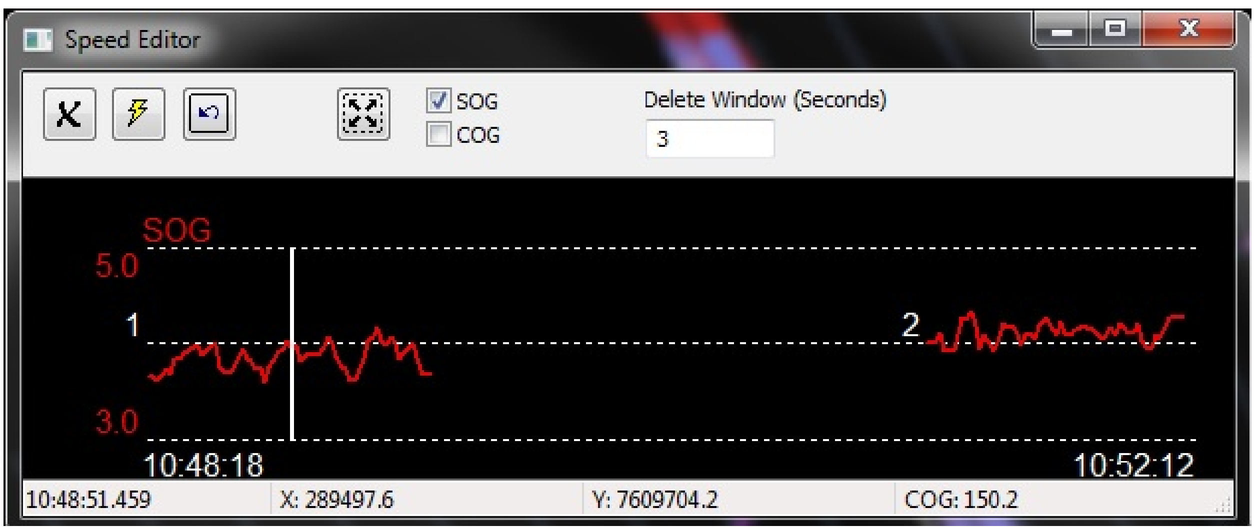
Once the pipeline position, in the two reciprocal lines, has been targeted, you need to determine the distance between the targets and determine the survey speed. The distance between the targets can be measured in the SHELL using “Measure” tool. If the targets are not visible in the SHELL, right-click on the Target Group in the SHELL tree and select “Synchronize” to make the Targets visible (Figure 3).

FIGURE 3. *Synchronize Targets in the SHELL to make them visible.*



To determine the average speed, load the RAW file into SBMAX64 (64-bit SINGLE BEAM EDITOR) and click the Speed button (Figure 4). When collecting data in sub-bottom profiling data in HYPACK®, a SEG-Y and RAW file are generated for each survey line. In Figure 4, the average speed for the two reciprocal survey lines is 4 knots (2 m/s). If the data was not collected in HYPACK® then the average survey speed value can be sourced from the survey notes/logs populated during the data collection.

FIGURE 4. *Speed Window in SBMAX64 used to Determine the Average Speed of the Reciprocal Latency Lines.*

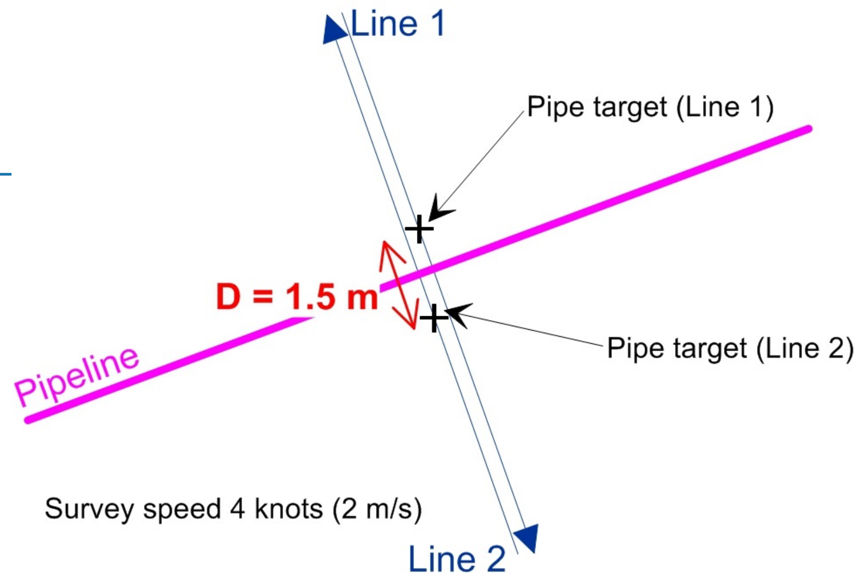


The calculation to determine the sub-bottom latency is very simple:

Divide the distance between the reciprocal line pipeline position targets by two and then divide by the survey speed, keeping all the units in common units (i.e. meters or feet). The resultant number is the latency in seconds.

LATENCY = (Distance/2) / Speed (all units in meters)

FIGURE 5. Measurements Required to Determine Latency in Sub-bottom Profiling Data.



In the Figure 5 example, the latency is calculated as follows:

Latency = (1.5 m/2) / 2 m/sec

= 0.75 seconds

Once the Latency value has been determined using pairs of reciprocal lines over a pipeline (buried or exposed) or small object visible in the data, this value can be populated in the Settings Window in the SUB-BOTTOM PROCESSING program (Figure 6). Once the value has been applied to the data in the project, you can re-digitize the pipeline positions and reflectors to determine the spatially correct position of features observed in the sub-bottom profiling data (Figure 7).

For added depth of burial accuracy on pipelines, it is recommended that the average speed of sound in water (from an SVP profile) and the speed of sound in sediment be input into the Sound Velocity tab under the Settings Window. The speed of sound in sediment varies from approximately 1,600-1,650 m/s but a more precise value can be obtained from the scientific literature describing the sediment types in the area.

FIGURE 6. Applying the Latency Value in the SUB-BOTTOM PROCESSING Program.

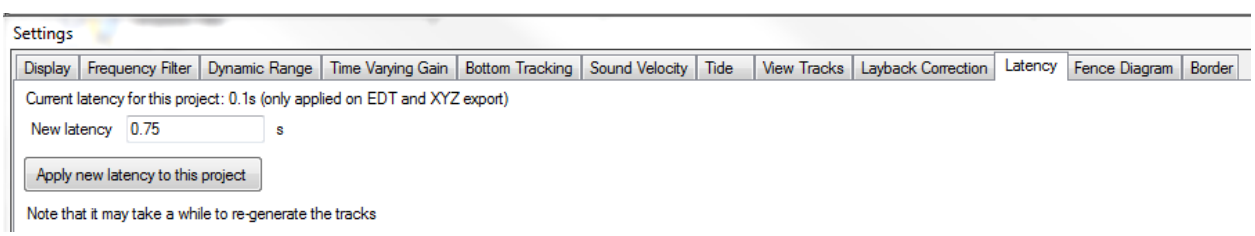


FIGURE 7. Target Editor showing the position (deliberately removed), water depth and depth of burial of the pipeline.