# THE PINGER

News from the Marine Team at Quester Tangent


# Seabed Classification: An Overview

## Well done Transit!

*The Marine Team congratulates our colleagues in Quester Tangent's* ***Transit Division*** *on the recent signing of* ***four*** *new contracts!*

- ⇒ **Alstom Transport** award of Monitoring & Diagnostic Systems on two major projects in the USA
- ⇒ **Bombardier, Inc** contract award for additional Monitoring & Diagnostic Systems on the New Jersey Transit multi-level rail cars.
- ⇒ **MotivePower, Inc** award for Monitoring & Diagnostic Systems, including train sequencing

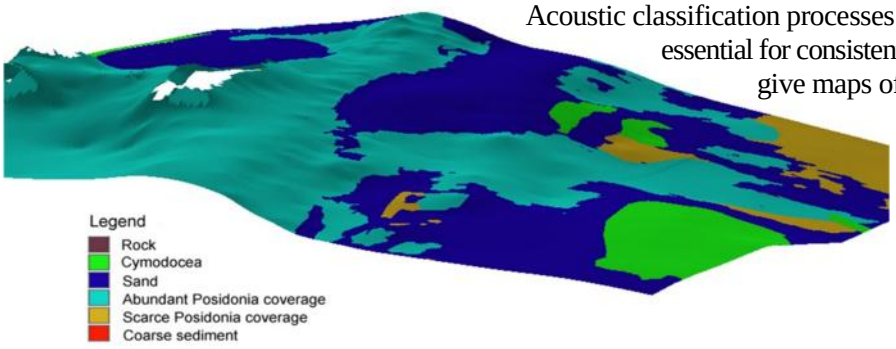
Quester Tangent has experienced strong annualized growth in the rail transit market, with much more to come.

Anyone with a scrolling echo sounder can see that seabed echoes contain more information than just water depth. Hard, rough seabeds reflect strongly, for example, and muddy bottoms have long echoes due to backscatter from within the mud. Observations like these have been used for years to make assumptions about seabed composition. QTC classification software suites are expert systems that classify seabeds similarly.

The theory of seabed backscatter at frequencies up to a few hundred kilohertz is well established, but complicated. It is an attractive idea to use that theory, given the sonar characteristics, survey geometry and the variables that describe the seabed to generate realistic echoes and images that directly characterize the seabed. In practice, though, it is difficult to use this theory in reverse. With echoes the problem is ambiguity – changing two variables such as roughness amplitude and density in opposite directions can produce very similar echoes. With images, practical issues arise including calibrating the sonar system, classifying only large homogeneous patches, and the theory is invalid at frequencies of common swath sonars.

Since inverting theory to directly measure sediment grain size and other characteristics is rarely practical, the alternate, well established approach is to assign classes by segmenting survey areas into regions that are acoustically similar. This is the QTC approach. Acoustic seabed classification organizes the seafloor into types or classes based on the nature of its acoustic backscatter. Attaching labels, such as sand or mud, to these areas requires some non-acoustic data, but much less of it is required to label acoustic classes than to map the seabed at a large set of grid points without using acoustics.

Acoustic classification processes start with careful quality control, absolutely essential for consistent classes free from artifacts. Four more steps give maps of acoustic classes:




*QTC class map from Imagenex Yellowfin sidescan sonar images collected near Ibiza, Spain. The interpolated class map is overlaid on vertically exaggerated bathymetry.* Posidonia *and* Cymodocea *are species of seagrass.* ***Surveyed by Ecohydros.***

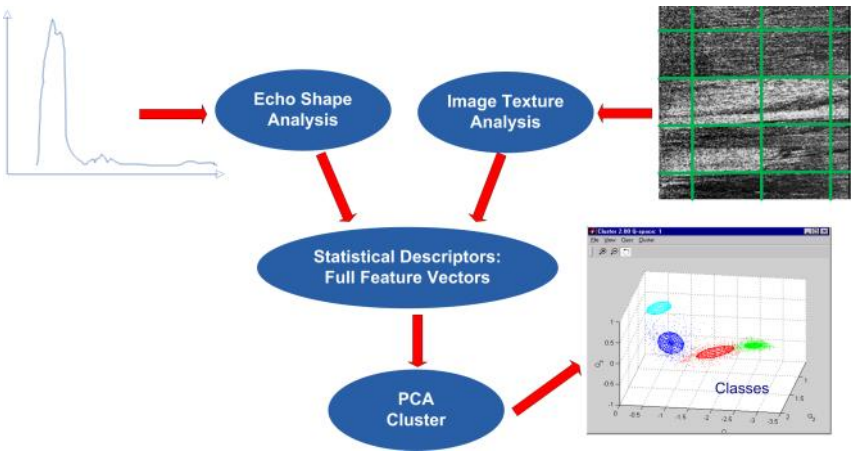
***Step 1:*** Echo time series and images must both be compensated for survey geometry. Echo duration is important for classification, but it depends on depth as well as on sediment type. Depth compensation by resampling echo time series, based on a linear model of duration vs. depth, removes dependence on depth from 0.7 m to more than 2 km. Image backscatter amplitudes depend on sediment

type, grazing angle, and range. The dependence on the last two must be removed for useful classification. If uncontrolled, these artifacts usually appear as class borders parallel to the ship track. Controlling them was perhaps the biggest challenge in developing an image-based classification system. Tables of amplitude as a function of range and angle (grazing angle for multibeam sonars, angle at the sonar for sidescan systems) are used to compensate effectively, even with sonars that are not calibrated.

***Step 2:*** The raw material for generating features is stacks of echo time series or matrices of backscatter amplitudes from rectangular sub-images, after compensation. The algorithms that generate features are distinct for the two types of data. For echoes, the features capture shape and spectral character; with images the features express backscatter amplitudes and textures. The user chooses the number of pings in a stack or the size of the sub-images, and thus controls the spatial resolution of the final class maps.

***Step 3:*** After features have been calculated, the steps for classifying echoes and images are the same: Principal components analysis (PCA) and clustering. PCA generates three combinations of features that capture almost all the survey variability. The final step, clustering, is done in feature space. It segments the acoustic data into classes that are acoustically homogenous in a statistically valid and useful way.

***Step 4:*** Classification methods like these assign classes to points along ship tracks. Relating class numbers to other data, such as species populations, requires interpolation to grid points. Categorical interpolation is distinct from interpolating continuous variables. QTC CLAMS is one software package that does so, yielding class maps ready for widespread use as layers in a GIS.




*Classification processes from stacks of echoes (left) or image portions (right), leading to descriptive features, PCA, and clusters in feature space.*

Maps of acoustic classes can be made from sounder echoes or sonar images as a value-added product from surveys done for other purposes. Ecologists, hydrographers, and many other users have made useful practical maps using processes like those described here, and embodied in Quester Tangent's products.

## Tony's Tips

Tony Tipple answers your questions about our products and their applications.

**Question:** *What level of training do your products require?*

**Tony:**

Our software is designed to be simple, easy to use, with a step-by-step menu-driven process to go from ping to classification map. Users with a modicum of knowledge about acoustics or sonar can quickly learn to process a data set. Still, training provides far more than simply a description of the mechanical process of turning your data into a map. It provides an opportunity to share with the trainee all our experience, tips and techniques to best understand the classification results and get the most out of any data set.

The key is that while users can proceed without training, generally people who invest a little time and money in training very quickly recoup that cost by reducing their overall time in reaching the point where they get good results, with high repeatability and with a high levels of confidence. It is for this reason that we always recommend clients undertake training.

The main avenues for training are:
***Training via Internet (TVI)*** — trainees remain in their office, training is provided via the Internet with a live trainer at QTC, typically about 7 sessions of 90 minutes each.
***Training on-site*** —typically a 2-day course, conducted either at our factory in BC, Canada, or at the client's site if preferred.

Please feel free to contact Tony at ttipple@questertangent.com with any other questions you may have.

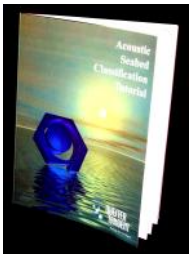
## Workshop Update…...

Jon Preston *assisting participants at the workshop in Klaipeda, Lithuania*

**Acoustic classification of the seabed is now a well-proven and mature technology.** Nevertheless, there are still many people who have had no direct exposure to this form of seabed mapping and are not familiar with the various technologies and products available. As leaders in the field, Quester Tangent would like to see the industry grow for the benefit of all. A prime way to promote this is through education. Accordingly QTC presents academic tutorials at appropriate conferences, such as the IEEE Oceans conferences, and is also currently engaged in presenting workshops at numerous venues globally.

The day-long workshops are typically presented by our chief scientist, Dr. Jon Preston. The focus is to provide participants with a working knowledge of various techniques for both single beam and swath classification, and to provide hands-on practical experience in processing swath data from a multibeam or sidescan sonar. Participants bring their own laptops to the workshops; data are loaded and processed to generate a detailed bottom classification map by the end of the day. Each step is accompanied by sound background theory and discussions of limitations and of complementary or alternate techniques.

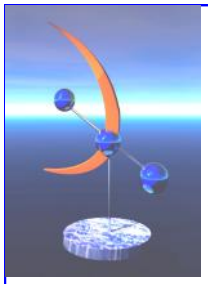
Workshops have recently been held in the USA (New England, Texas and Washington State) and the Baltic states (Lithuania and Estonia), with the next scheduled for April 4th in Southampton (the day prior to the *Ocean Business* conference), and Mexico (Merida) following in May.



***Please contact Tony Tipple at ttipple@questertangent.com if you would be interested in either hosting or attending a workshop.***

### Next tutorial

***The next Seabed Classification tutorial is scheduled for the Oceans Conference in September 2011, Hawaii, USA***



### International Partner…….Focus on:

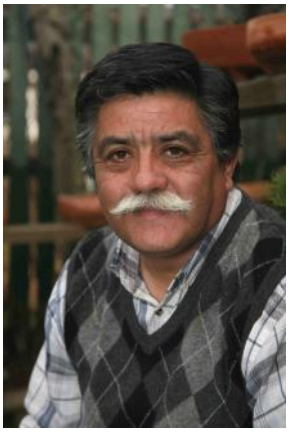
### *Alakaluf Ltda*, Chile

Alakaluf Ltda., a company active for 22 years in the oceanographic market, represents Quester Tangent in Chile. The company is based in the southern city of Punta Arenas, the largest city and port in the Strait of Magellan, the nearest to the South American entrance to Antarctica and a stone's throw from Tierra del Fuego.

Alakaluf Ltda. provides a wide range of products and services with a focus on building strong personal relationships and delivery of high quality results. Products include systems for physical oceanography, hydrographic and biological oceanography surveys, sidescan, sub-bottom and hydro-acoustic sonars. Services include surveys for seabed mapping, coastal operations and the development and siting of alternative energy operations.

Its founder, Sergio Andrade, is a marine biologist from University of Concepcion. He completed his M.Sc. in Marine Environmental Sciences at the State University of New York at Stony Brook and has been working in the ocean industry sector since graduation. Sergio has also been very active within the Chilean marine energy sector, and is President of the consortium ***Enermar***, focused on bringing renewable energy to Chile. Information on this project is available at ***www.enermar.cl***.

Visit Alakaluf at ***www.alakaluf.cl***, or contact Sergio at ***alakaluf@tie.cl.***



**Sergio Andrade,** *Head Honcho and founder of Alakaluf Ltda*

## Spotlight on…. QTRT
Real-time Classification

### QTRT—"On-the-fly" Single Beam Classification

Classification and mapping of the seabed in real-time with single beam echo sounders is technology that has been available for some years. However, this has always required that the user add additional hardware (the QTC VIEW), connected to the echo sounder, to acquire the necessary digital information and make it available to the classification software for processing and real-time display of classification results.

***With the introduction of QTRT this has changed.*** This new software from Quester Tangent enables real-time classification of the seabed using a direct link to a suitable echo sounder, no additional hardware required. QTRT provides for the development of a classification catalogue and the subsequent display of classification results overlaid in real-time on an ENC as the survey progresses, while the source data are logged in the background for post-processing if desired.

QTRT reduces the capital cost required to deliver seabed classification with an appropriate echo sounder, and provides the user with options for "on-the-fly" results in the field as well as the opportunity for subsequent in-depth analysis in the office.

QTRT is currently available for use with selected **Teledyne Odom** and **Atlas Deso** echo sounders. Contact QTC to see if your sounder could also be supported.

## Proud Owners

Quester Tangent's new flagship product for classification of swath acoustic data, QTC SWATHVIEW, was released at the end of 2010. Now, early in 2011, we already have 30 users! The software has also led us into new countries, Lithuania and Romania, as we have added the ***Klaipeda State Seaport Authority*** and the ***Romanian Marine Research Institute*** to our family of users. Amongst our other new clients on the global scene are ***Maju Geohydro Sdn Bhd*** in Malaysia, the ***National Taiwan University*** and ***GEMS International*** in the UK. Closer to home we have sent QTC SWATHVIEW licenses to ***BC Hydro*** in British Columbia, and in the USA to the ***Maryland Geological Survey***, the ***University of Michigan***, the ***Ohio Department of Natural Resources*** and ***Chustz Surveying***, among others.

We have also seen a resurgence of interest in single beam classification with recent sales to the ***Defence Science and Technology Organisation*** (Australia), ***NOAA OAR*** (Ann Arbor, MI), ***Ohio Department of Natural Resources***, ***Fisheries and Oceans Canada*** (St Andrews) and ***Parks Canada*** (Vancouver).

Our new **Training via Internet** (TVI) initiative also continues to be very popular, with 4 courses presented in the last month alone. TVI is a cost-effective and efficient way to get a very good head-start on using our products.

**TO CONTACT US**

**Chris Elliott**
Director, Marine
Tel: 250-654 3301
Cell: 250-744 9968
celliott@questertangent.com

**Tony Tipple**
Senior Technical Sales
Tel: 250-654 3308
Cell: 250-516 1661
ttipple@questertangent.com

**Jon Preston**
Chief Scientist
Tel: 250-654 3316
jpreston@questertangent.com

**Tom Younger**
Lead Engineer
Tel: 250-654 3324
tyounger@questertangent.com

**Tony Christney**
Lead Developer
Tel: 250-654 3316
tchristney@questertangent.com

*Compiled and edited by:*
**Martina Elliott**—Elmar Studio
elltalk@shaw.ca

Quester Tangent
6582 Bryn Road
Saanichton, British Columbia
Canada, V8M 1X6
Tel: +1-250-656-6677
Email: info@questertangent.com
Web: www.questertangent.com

*Do you have any articles of interest you would like to contribute to **The Pinger**?*

If you do—please contact Chris Elliott