Beam Patterns in GEOCODER™

By Dave Maddock

In a previous article, I explained how GEOCODER™ blends overlapping lines in the mosaic (Sounding Better, March 2009). In this article, I'm going to explain beam patterns: what they are, how to extract them, and how GEOCODER™ uses them.

The backscatter response that is ultimately logged to your data files is a mixed bag of backscatter from the seafloor distorted by gain and power settings, TVG/AVG, the slope of the seafloor, and TX/RX beam patterns. The aim of GEOCODER™ is to quantify and remove each component, peeling back the layers of distortion, to isolate only that response which is a function of the seafloor itself. TX beam pattern is only one such radiometric distortion and is what I will focus on here.

WHAT IS A BEAM PATTERN?

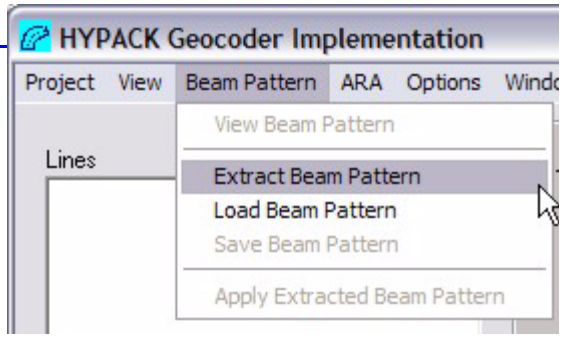
The beam pattern of a sonar is a radiometric distortion of the backscatter resulting from unique anomalies in transmit power. Think of it as the sonar's signature on the backscatter. Though each sonar has its own pattern, sonars of the same model will exhibit very similar patterns. If we can determine the pattern for our sonar's transducers, GEOCODER™ can correct for this distortion as it does for changes in gain and power settings, area of insonification, and seafloor slope.

I should mention that often this correction can be very subtle visually, but is a key component for obtaining accurate ARA (Angular Response Analysis) results as I will explain.

HOW DOES GEOCODER™ EXTRACT THE BEAM PATTERN?

In the case of some values, such as gain and power, we can determine the appropriate correction using known runtime settings. Others, such as area correction and seafloor slope, can be quantified using a bathymetry model and range/angle data. After these corrections are made, what we are left with is the combined backscatter response from the seafloor and beam pattern.

FIGURE 1. *Extracting the Beam Pattern*

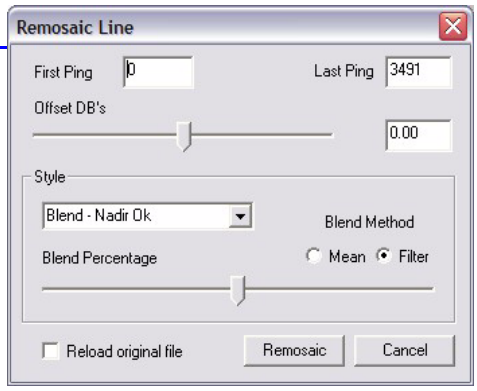


To extract the beam pattern, GEOCODER™ employs the modeling techniques used in ARA. When using ARA analysis for bottom classification, we correct for a known beam pattern and assume what is left is the “pure” response from the seafloor. This “pure” response can be modeled to figure out bottom type. However, to extract the beam pattern we do this process in reverse. That is, we survey a known bottom type (ideally, a flat sandy area), then correct the observed response with the model of this bottom type. What is left must be the beam pattern!

STEP-BY-STEP EXTRACTION

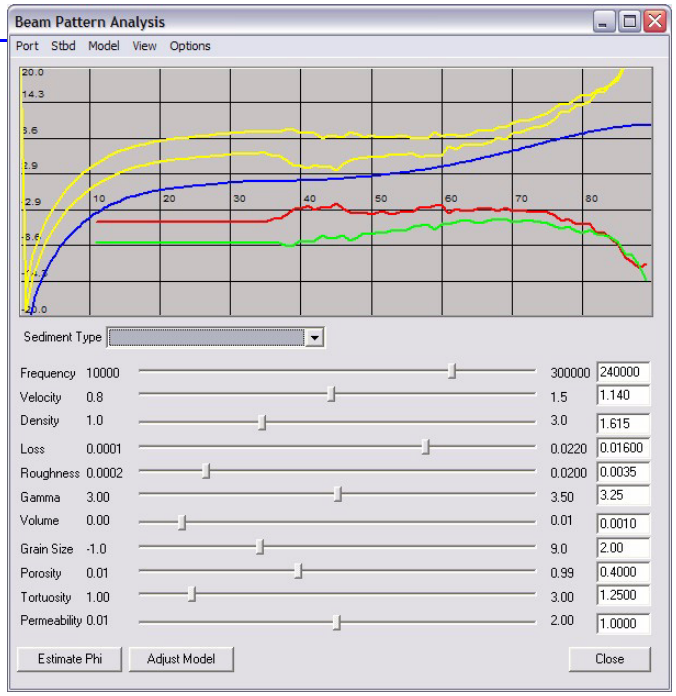
1. **Log a short line over a flat, sandy area**.
2. **Load the data into GEOCODER™ and choose "Extract Beam Pattern" from the menu**.

FIGURE 2. *Extracting the Beam Pattern*



3. **Select a 500 ping section of the selected line in the "Remosaic Line" dialog**.
   - Change the first and last ping values.
   - You can move the "Offset dBs" slider to shade the selected area on the display.
4. **Press Remosaic**. The beam pattern window will pop up, displaying the extracted pattern. The pattern will be loaded into memory when this dialog is closed.

FIGURE 3. *Beam Pattern Window*



The model sliders default to medium sand. This is the bottom type model which will used to extract the pattern.

5. If you know the specifics of your bottom type from ground truthing, you can modify the sliders as needed.
6. **Close the dialog.** The "Apply beam pattern" option will be automatically turned on.
7. **Make mosaic again** to apply the new correction to your mosaic.
8. **Save the pattern to a file for future use.** (You need not extract the same pattern over and over.)

INTERPRETING THE BP GRAPH

The beam pattern graph shows five lines:

- **Red** and **green** are the port and starboard observed angular responses.
- **Blue** is the model of the bottom type from the parameters chosen with the sliders.
- The **yellow** lines are the beam pattern, which is calculated by subtracting the blue line from the red and green lines.

How does the Beam Pattern affect my mosaic?

Visually, you may not notice a significant difference. However, it is crucial when using ARA analysis to account for the beam pattern. Remember that the quality of the ARA process rests on how well you can recover the “pure” backscatter response from the seafloor. If you do not use a beam pattern, the accuracy of the bottom classification is decreased as the angular response of the seafloor is distorted by the undetermined beam pattern.