

Chirp Sub-Bottom Profiler Processing—A Review

Chirp Signals May be Recorded as Correlates, Analytic or Envelope

By Paul Henkart

Geophysical Analyst

Scripps Institution of Oceanography

La Jolla, California

Hull-mounted and towed sub-bottom profilers have become common within the U.S. academic community. While these systems may be marketed as “echosounder” or “bathymetric,” they are far more powerful and complex than the depth finders of years ago. Echosounders typically used a constant waveform signal of 3.5 or 12 kilohertz, measuring the two-way travel time to the seafloor and sometimes penetrating the sub-bottom. The replacement sub-bottom profilers emit a chirp signal that is usually several kilohertz wide and often penetrates the bottom 100 meters or more.

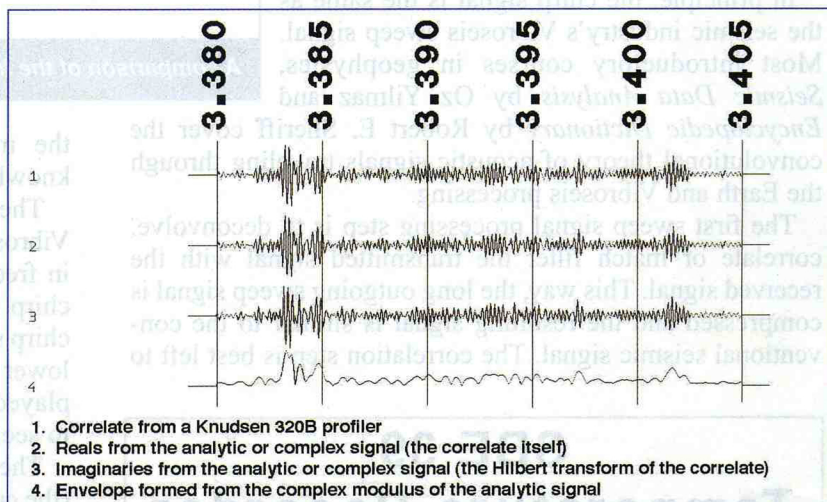
In the early days of chirp sub-bottom profiler development, the profilers required specialists or experts in order to operate them. These days, the chirp profiler is considered just another underway data acquisition device, and the shipboard technician may not have had much training in its use.

The chirp profiler operator must choose recording and display parameters, such as gain and chirp frequency. Hull-mounted profilers are more than likely found on oceanographic ships with a multibeam echosounder mapping system operating at 12 kilohertz and a current profiler operating at 50 kilohertz. Sub-bottom profilers get more depth penetration with low frequency, thus, a chirp center frequency near the old 3.5 kilohertz is generally used.

Many of the chirp recording and processing parameters are similar to the old echosounder parameters. Some chirp systems even use the same transducers, so the transducer transmit and receive gain functions are the same. The display on the old echosounders consisted of burning a spot on a piece of paper so that an increase in seismic amplitude caused a more intense burn spot. Today’s profilers create grayscale plots of the signal envelope on computer monitors and thermal raster plotters.

Variable Velocity

The old echosounders were used mostly to measure seafloor depth, and periodically recorded the depth as a number in addition to the paper record. These systems used a



A comparison of the time domain of the correlate, analytic and envelope signals.

single velocity value (750 meters per second) to convert two-way travel time to depth. Expendable bathythermographs (XBTs) were, and still are, deployed to measure the velocity of sound in water, but the old depth systems applied the varying velocity after the fact—in the shoreside laboratory months later. Today’s bathymetric multibeam mapping systems allow the full XBT velocity function, and allow this to vary spatially in real time. There could/should be a whole article written just on the different types of velocity functions used to convert time to depth. A marine technician must know which system uses which velocity function for which purpose. A technician also has to educate everybody onboard as to why there is a difference among the depth readings from the different systems.

Types of Signals

The modern sub-bottom profiler chirp signal is typically 20 to 50 milliseconds in length and sweeps three to four-kilohertz frequencies in that time. One hull-mounted profiler manufacturer uses a four-kilohertz-wide signal with a center frequency of 3.5 kilohertz (sweeping from 1.5 to 5.5 kilohertz) and another sweeps from three to six kilohertz (a three-kilohertz bandwidth with a center frequency of 4.5 kilohertz). Increasing the length of the outgoing signal increases the power of the outgoing signal.