Instrument Lab Lamont-Doherty Earth Observatory of Columbia University 61 Route 9W Palisades, NY 10964	
Subject:	SeaBeam 2112 performance during HLY-03-Td
Project:	Healy Multibeam Support
Created:	August 28, 2003
Updated:	August 30, 2003
Engineer:	Dale Chayes
Doc No.:	
Revision:	
Ref. 1	SB2112 External Interface Document Rev H (L3/SBI)
Ref. 2	L3/SeaBeam Hydrophone Damage Analysis Report (L3/SBI)
Ref. 3	SB2112 Hydrophone test report from April 2003 (L3/SBI)
Ref. 4	SB2112 Hydrophone measurements from June, 2003 (Chayes)

The following observations characterize the performance of the SeaBeam 2112 multiple formed beam swath mapping sonar on the Healy during cruise HLY-03-Td.

1 Cruise Info

Healy cruise HLY-03-Td departed from Thule, Greenland on Tuesday, August 19th, transited through the northern Northwest Passage, through the Prince of Wales Strait and arrived off of Barrow, Alaska on Saturday, August 30, 2003.

The goal of this cruise was to take advantage of the repositioning of the vessel between funded science legs HLY-0301 (St. John's to Thule) and HLY-0302 (Barrow to Barrow) to collect underway data including multibeam swath mapping, subbottom profiler, thermosalinograph (TSG), weather, acoustic doppler current profiler (ADCP), fluorescence marine mammal observations, and expendable probes (XCTDS.) Additional efforts during this cruise included ship's power system testing, outreach, and development of science metadata standards and procedures.

2 Watch standing

Routine watch standing by members of the science party was provided for the multibeam, subbottom (Bathy-2000) and ADCP (75 and 150BB.) The ship’s MSTs also provided a watch stander and handled XCTD probe launches.

3 System Overview

The multibeam installed on the Healy for this cruise is a SeaBeam model 2112 operating at 12 kiloHertz. It has sixty (60) hydrophones in the receive array and 12 projectors in the transmit array. The arrays are arranged in a Mills Cross at approximately frame 54.

SeaBeam Real-Time Sonar System Software version 1.2.1A was used for the entire cruise.

4 Multibeam inputs

4.1 Sound speed at the keel

Speed of sound was derived from the forward and aft SeaBird Thermosalinographs in real-time, reformatted and provided to the SeaBeam. For some portions of the cruise the sound speed at the keel was forced into manual mode to avoid a bug in the SB2112 software (see section 5.3.)

Sound speed was calculated using the Chen Millero 1977 equation and inputs of conductivity (converted to salinity) and temperature from the active TSG.

4.2 Sound speed profiles

Sound speed profiles were derived XCTD profiles. The speed of sound as calculated by the Sippican software was re-sampled with *mbmvelocitytool* and loaded into the SB2112 via ftp..

4.3 Navigation and heading

The real-time navigation input for the entire cruise was provided by the ship's integrated bridge system. There is no other reliable source capable of providing the right data in the correct formats available on the ship.

Heading derived from the ship's MK-37 gyrocompasses was provided through the IBS. There was no other continuously available source on board during this leg.

4.4 Time synchronization

Time of day synchronization was provided from the IBS for the entire cruise. There was no other source available during this cruise.

4.5 Attitude

A Kongsberg Simrad Seatex MRU6 serial number 225 vertical reference was used for the entire cruise. There is no other vertical reference.

5 Performance Issues:

5.1 Damaged hydrophones

Approximately 17 hydrophones in the receive array exhibit erroneous capacitance and/or electrical shorts. At the recommendation of L3/SeaBeam (see reference) these hydrophones were shorted in the junction boxes.

5.2 Thermosalinograph (TSG)

The SB2112 installation on the Healy (in addition to other science systems) depends up real-time measurements of water temperature and conductivity to estimate the speed of sound used in the beam former. Errors in estimating this parameter are very hard if not impossible to accurately remove after the fact. Therefore, problem with water flow that result in poor performance of the TSG and hence inaccurate sound speed are critical.

5.2.1 Forward Thermosalinograph

The science seawater intake was out of service for several extended periods during this cruise. Each initial failure was due to the intake becoming clogged with ice while operating in the marginal ice zone or while actively breaking ice. On each occasion, there was a substantial delay after entering open water during which the intake system remained frozen. The un-freezing process could be materially improved by addition of (steam?) heating around the outside of the plumbing. This heat would only be applied to un-freeze the intake, not during normal operation.

5.2.2 Aft Thermosalinograph

The aft TSG was the primary source of data for estimating speed of sound at the keel during this cruise. There were a few instances where the flow rate was low but these were resolved relatively quickly once reported.

An automatic method of reporting low flow should be implemented. This will require installation of flow rate sensors. The sensors do not need to be

5.3 Sound speed at the keel

An old bug in accepting sound speed at the keel has re-surfaced in the SeaBeam 2112. This bug is encountered when sound speeds less than 1440 m/s are provided via the real-time interface. When presented with such a low sound speed it appears that the SB2112 (version 1.2.1A) software forwards a zero speed to the beam former and no formed beam data is provided for the subsequent ping.

During several periods during this cruise, we encountered cold, relatively fresh water that results in sound speeds well below 1440 m/s. During these periods, we worked around this bug by switching to manual sound speed at the keel and using a fixed value of 1440.5 m/s.

5.4 Navigation heading and time

A few times during this cruise, the integrated bridge system (IBS) had trouble and stopped sending navigation data to the SB2112. This results in a number of errors in the data.

Most if not all of these problems can be resolved in post processing.

5.4.1 Loss of time synchronization

At least once during this cruise the IBS sent erroneous time and date synchronization data to the SB2112. The date of the erroneous data was at least two days in the future.

In response to this event, at least some if not all of the computer nodes in the IBS were rebooted to clear the error.

5.4.2 Navigation resolution

The format for navigation input to the SB2112 on the Healy only allows for two places for decimal minutes of latitude and longitude. The resulting truncation in precision results in some jitter in the real-time display.

The navigation accuracy in the multibeam data can be improved in post processing by merging data from either of the existing P-Code receivers.

5.5 Shallow water performance

The SB2112 on the Healy is not capable of shortening it's transmit array when operating in shallow water. As a result, the data in less than about 250m of water is taken with the sonar operating in the near field. The resulting data quality is substantially worse than data collected in deeper water.

5.6 VRU error messages

As in previous cruises, there were intermittent bursts of "FATAL" error messages reported in the Status window by the SB2112. Unfortunately, these errors are not recorded which makes documenting correlation with external events difficult.

There is no direct evidence that the bathymetry data is significantly degraded in association with these errors but it is possible. Perhaps more importantly, these errors are very alarming to watch standers.

The long cable run between the SB2112 (in the Computer Lab) and the VRU (in the IC/Gyro Space) provides power down to the VRU and data communications between the VRU and the SB2112 receiver processor.

It is possible that EMI is causing interference with the communications between the two devices. Options for addressing this issue include moving the VRU to the Computer Lab, adding EMI filters, installing filtered line drivers and re-routing the cable. Careful thought should be given prior to future effort.

5.7 VRU alignment

5.8 Ping rate

This SB2112 has a minimum ping interval of about 1.5 seconds. As a result, along track sampling in less than about 500m of water is significantly less that desirable.