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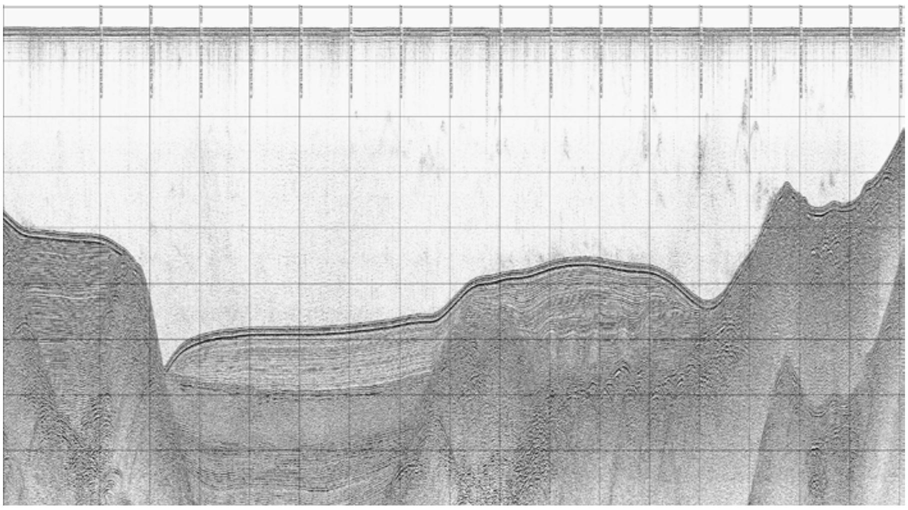
Surface tow boomer survey of Loch Linnhe.

Cruise: 2010_1_SAMS

Internal Report CR/10/046

Written by Nick Smart, introduction written by Kate McIntyre.



BRITISH GEOLOGICAL SURVEY

MARINE GEOSCIENCES CRUISE REPORT

INTERNAL REPORT **CR/10/046**

Surface tow boomer survey of Loch Linnhe.

Michael Wilson, Nick Smart

Contributors

Dr. John Howe and Kate McIntyre from The Scottish Association for Marine Science (SAMS)

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Front cover

Seismic extract from a line ran in this survey.

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Foreword

This report provides information on the collaboration between BGS and SAMS on the completion of a seismic survey of Loch Linnhe. The survey ran from the 11th to the 15th of January, on board the vessel RV Calanus.

The project was lead by PhD student Kate McIntyre and Dr. John Howe of SAMS; BGS were invited to provide personnel and equipment for the completion of a surface towed boomer survey of Loch Linnhe on the west coast of Scotland. The survey plan was based on a previously conducted multibeam survey from February 2009 (as shown in figure 1b), the aim was to provide further geological data in the form of sub bottom seismic to analyse alongside the bathymetry. The line names shown in figure 1b do not correspond to the line names run in this survey. See appendix 2 for run line numbers.

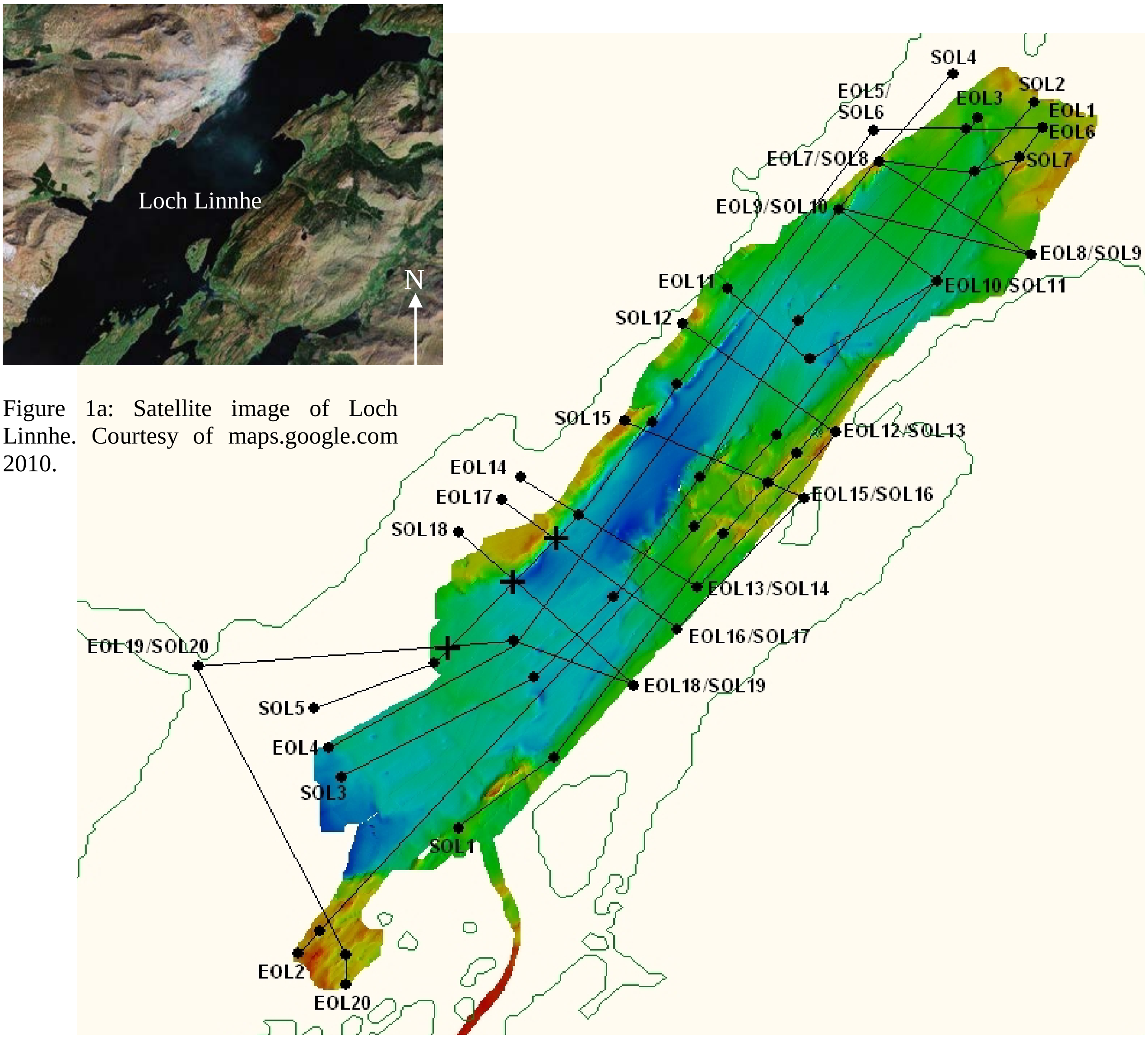

Figure 1a: Satellite image of Loch Linnhe. Courtesy of maps.google.com 2010.

Figure 1b: Multibeam bathymetry data of Loch Linnhe collected by SAMS in February 2009 using a Reson 8124 (SAMS 2009).

Acknowledgements

As well as John Howe and Kate McIntyre, BGS would like to express their gratitude to the helmsman and crew onboard the RV Calanus for their support, hospitality and professional attitude, all of which contributed to a pleasant and successful cruise.

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FIGURES

1. Introduction

Loch Linnhe boomer seismic reflection survey, January 2010

Kate L. McIntyre, John A. Howe, Tom Bradwell & Tracy Shimmield.

Scottish Association for Marine Science, Dunstaffnage Marine Laboratory, Oban, Dunbeg, PA37 1QA.

Loch Linnhe is situated on the west coast of Scotland, representing the south-westerly end of the Great Glen Fault which cuts diagonally across the country to the Moray Firth. During repeated episodes of Quaternary glaciation, Loch Linnhe was a major drainage conduit for outlet glaciers from the main Scottish ice sheet. Models show how ice build-up at the onset of glaciation was concentrated around Rannoch Moor to the west (Golledge et al. 2008), and ice flowed from this direction into Loch Linnhe via the tributary fjord basins of Lochs Leven, Etive and Creran. The last glacial readvance to affect the area occurred during the Younger Dryas stadial of 12.8-11.5 ka BP, during which many of the west coast fjord basins were reoccupied by glacial ice. The maximum limit of the Younger Dryas glacier in Loch Linnhe was identified by Thorp (1986) as occurring between Duror and Kentallen, just to the southwest of the Corran Narrows, based on a series of outwash deposits mapped onshore in this area. The Younger Dryas ice-cap model of Golledge et al. (2008), however, suggests that ice readvanced much further down the loch than this, terminating close to the northern tip of Lismore.

In February 2009 a multibeam sonar survey was carried out in the loch between Lismore and the Corran Narrows, as part of a NERC-funded PhD studentship (Kate McIntyre) co-supervised by the Scottish Association for Marine Science (SAMS), Oban, and the British Geological Society (BGS), Edinburgh. Data was gathered from SAMS research vessel RV Calanus using a Reson 8124 Multibeam Sonar. The survey revealed a number of interesting features on the seabed, including a suite of recessional moraines concentrated mainly in shallow water (~40-50m) south of Duror, ubiquitous pockmarks occurring both singly and in linear chains throughout the survey area, and tidally-scoured depressions along the base of topographic seabed highs. More ambiguous geomorphology included a large fan-like structure at the north-east end of the survey area, and moraine-like ridges/banks features in the south, close to Lismore.

The present seismic survey (11th-15th January 2010) has been planned using this multibeam data. It is anticipated that the boomer reflection profiles obtained will provide further insight into the nature of the features observed and the processes which produced them. Additionally, careful interpretation of the profiles should allow a stratigraphy to be constructed showing the relative ages of the features and hence chronology of events in the loch. In particular, the timing and extent of the Younger Dryas ice sheet is hoped to be revealed from a combination of offshore geophysics (multibeam and boomer surveys) and sedimentological data (sediment cores with radiocarbon dating).

2. Summary

MOBILISATION

BGS surface tow boomer equipment relating was mobilised onto the vessel RV Calanus on the 11th of January 2010 at SAMS, Oban.

Equipment plus personnel were transported via hire van from Loanhead to Oban on the 11th of January. The van left Loanhead at 0830hrs and arrived in Oban at 1145hrs. Mobilisation commenced that day from 1230hrs, all equipment was onboard and secured in place by 1600hrs.

Connectivity and communications were established on the morning of the 12th of January, the primary GPS output from the vessel was not operational; therefore the Coda system was plugged directly into the Ashtec ADU3 system. There was an initial problem receiving the output string into coda, this was due to a faulty cable. This delayed the start time of the survey by approximately 40 minutes.

RV Calanus had recently installed a new echo sounder, which at the time of the survey was not fully operational and an output string had not been setup, therefore depths were not available.

The vessel set course for the first survey site at 0840hrs and arrived on site at 0955hrs for deployment of the surface tow boomer.

SURVEY

Please note that line numbers run below are numbered in the order they were run and do not directly correspond to the line numbers in figure 1b. See appendix 2b for line number correlation.

<u>Monday 11th January:</u>

0830hrs – Leave Loanhead for Oban.

1145hrs – Arrive at SAMS Oban.

1230hrs – Commence mobilisation.

1600hrs – Equipment onboard and in place, lab equipment tied down and secure.

<u>Tuesday 12th January:</u>

0800hrs – Arrived at RV Calanus, the first task was to establish a Nav output from the vessel. The primary GPS output from the vessel did not work; therefore Nav was taken directly from the onboard Ashtec ADU system.

0840hrs – Vessel was underway to the first survey site.

0955hrs – Arrive at first survey line, equipment was deployed and tested.

1130hrs – SOL 1, 14.6km in a NE direction. All survey lines were carried out at 4-5knts.

1200hrs – Sea Earth deployed.

1202hrs – Bang box restarted

1316hrs – EOL 1

1323hrs – SOL 2, 18km in a SW direction.

1532hrs – EOL 2

1545hrs – Returning to SAMS

1700hrs – Alongside. Equipment was left onboard the vessel at the bottom of a secure pontoon.

Wednesday 13th January:

0810hrs – On route to line 3 of the survey.

0935hrs – On station, equipment deployed.

0951hrs – SOL 3, 14.8km in a NE direction.

1145hrs – EOL 3

1153 – SOL 4, 14.8km in a SW direction.

1349hrs – EOL 4

1417hrs – SOL 5, 3.7km in a SE direction.

1442hrs – EOL 5

1447hrs – SOL 6, 6.9km in a NW-SW direction, change in direction due to dog leg in line.

1531 – EOL 6

1535hrs – SOL 7, 5.6km in a SE direction

1615hrs – EOL 7. Heading back to SAMS.

1730hrs – Alongside.

Thursday 14th January:

0800hrs – On route to line 8.

0948hrs – SOL 8, 13km in a NE direction.

1000hrs – Printer stopped at fix 606. Resume fix 607.

1128hrs – EOL 8

1128hrs – SOL 9, 2.7km in an E direction.

1148hrs – EOL 9.

1151hrs – SOL 10, 4.7km in a SW-W direction, change in direction due to dog leg in line.

1210hrs – EOL 10

1213hrs – SOL 11, 2.9km in an E direction.

1237hrs – EOL 11

1238hrs – SOL 12, 3.2km in a W direction.

1259hrs – EOL 12

1303hrs – SOL 13, 2.1km in an E direction.

1318hrs? – EOL 13

1320hrs – SOL 14, 1.7km in a W direction.

1348hrs – EOL 14

1355hrs – SOL 15, 3km in an E direction

1413hrs – EOL 15

1414hrs – SOL 16, 3.3km in a SW direction.

1436hrs – EOL 16

1437hrs – SOL 17, 3.3km in a W direction.

1500hrs – EOL 17

1505hrs – SOL 18, 3.1km in a SE direction.

1529hrs – EOL 18

1530hrs – SOL 19, 2.9km in a SW direction

1549hrs – EOL 19

1550hrs – SOL 20, 3.5km in a NW direction.

1611hrs – EOL 20, End of survey lines. On route back to SAMS

1700hrs – Alongside. Equipment was disconnected, boomer left on aft deck with hydrophones and boomer cable stored in the wet lab.

DE-MOBILISATION

Friday 15th January:

0900hrs – Demob commenced. Equipment repackaged and loaded into hire van.

1015hrs – Leave SAMS.

1330hrs – Arrive at Loanhead.

3. Navigation

AQUISITION

Navigation data was output by the vessels Ashtec ADU3 system. The Ashtec GPS antenna is offset from the vessels central reference point by 0.050 m to port, 2.60 m forward and 3.65 m above.

ADU3 specifications can be seen in figure 2 below.

Parameter	Description
Attitude accuracy (1x1M antenna array) • Heading • Pitch/Roll	• 0.4° static, 0.2° dynamic • 0.8° static, 0.4° dynamic
Positional accuracy • Stand-alone • Real-time differential (optional) • Post-processed	• 100m (95% with selective availability ON) • 2m (2D rms) 3m (3D rms) • 1cm + 2ppm
Velocity accuracy (PDOP<4)	1 cm/second
Time to first fix: • Warm start • No almanac (cold start)	• < 3 minutes • < 6 minutes
Update rate	5 Hz
Input voltage	12-32 VDC via 3-pin non-waterproof connector
Power requirements	12 watts maximum
Temperature limits	-20° to +55° C
Speed limit	1000 knots
Altitude	60,000 feet (higher available with special authorization)

Figure 2: Technical and physical specifications for the ADU3 onboard the RV Calanus (Ashtech 2009).

The lat and long data was streamed to the Coda DA2000 via NMEA 0183 GGA type data string with ‘8 none 1’ configuration, there was no navigation analysis or monitoring onboard.

The following navigation parameters were used throughout the survey:

Reference spheroid: **WGS84**

Projection: **UTM Zone 30N**

Time zone: **GMT**

Navigation information was referenced to the common reference point (CRP) on board the vessel. This is described in the layback diagram (Appendix 1).

4. Geophysical Survey Equipment

This survey was carried out using the following pieces of equipment:

- AA300 Boomer plate
- CSP-D 2400
- Coda DA2000
- SIG hydrophone
- BGS amplifier
- Thermal printer
- Picoscope

300J was generated and supplied to the boomer plate from the CSP-D 2400. The boomer, towed from the port side of the vessel, fired 3 times a second consistently throughout the survey, never missing a shot. Reflections were picked up via the 10m multichannel SIG hydrophone on the starboard side of the vessel, 3 channels of a possible 7 were active, the hydrophone height was varied using an electronic air pump when necessary. The signal was fed through the BSG amplifier in which the gain, pre and post filter, was altered to optimise the output. The seismic data was fed into the Coda DA2000 system where filters and further gain controls, including Time Varying Filter (TVF) and Time Varying Gain (TVG), were applied to further optimise the image output. Filter settings etc can be found in the .set files within the folder structure. Paper traces were printed out via the thermal printer with scales lines, fix numbers and positions added. One issue arose with Coda, in that when printing the hardcopies, scales line values were not printed. These had to be added by hand post printing. Aside from this, all pieces of equipment performed to the expected standard without any malfunction.

Coda settings:

TVF: Low Pass = 2000Hz cut-off

High Pass = 800Hz cut-off

Band Pass = 1800 – 2000Hz

Voltage range of active channels: ±5V

Operational requirements:

The boomer required the use of the vessels A-frame and winch to lift it over the railings outlining the stern of the vessel; the winch required a crew member to operate. A removable boom was used to deploy the hydrophone over the starboard side of the vessel, the hydrophone was looped through the boom and extended out to starboard; the boom was secured to the stern railings with rope.

There had to be good cable routes leading from the deck into the main labs to accommodate the boomer cable and hydrophone. The boomer cable was run down the port side of the vessel into the wet lab, the hydrophone was tied off on the starboard side of the vessel to maintain a constant length, the excess was lead across the gantry, from starboard to port, and into the wet lab.

The wet lab was a suitable place to accommodate the bang box, suitable power supplies were available, the cables had a shorted route to follow, and bang box controls were easily accessible from the main lab by means of an access hatch.

The main lab, which was situated forward of the wet lab on the port side, was to accommodate the Thermal printer, the DA2000, BGS amplifier, 2x monitors, picoscope and a laptop. Suitable power supplies were required for all these pieces of equipment, the Calanus provided multiple power sockets in convenient locations.

Equipment needed to be secured in place within the lab, this was done with Velcro and rope, the Calanus desktops already had movable eyes mounted in the table, aiding to the ease of securing equipment.

When running survey lines, the skipper aimed to run lines as straight as possible. When turning between lines, an appropriate turning circle was used as not to tangle the boomer and the hydrophone together or with the propeller of the vessel, and also at a slow enough speed so the boomer didn't sink during the turn.

5. Health & safety

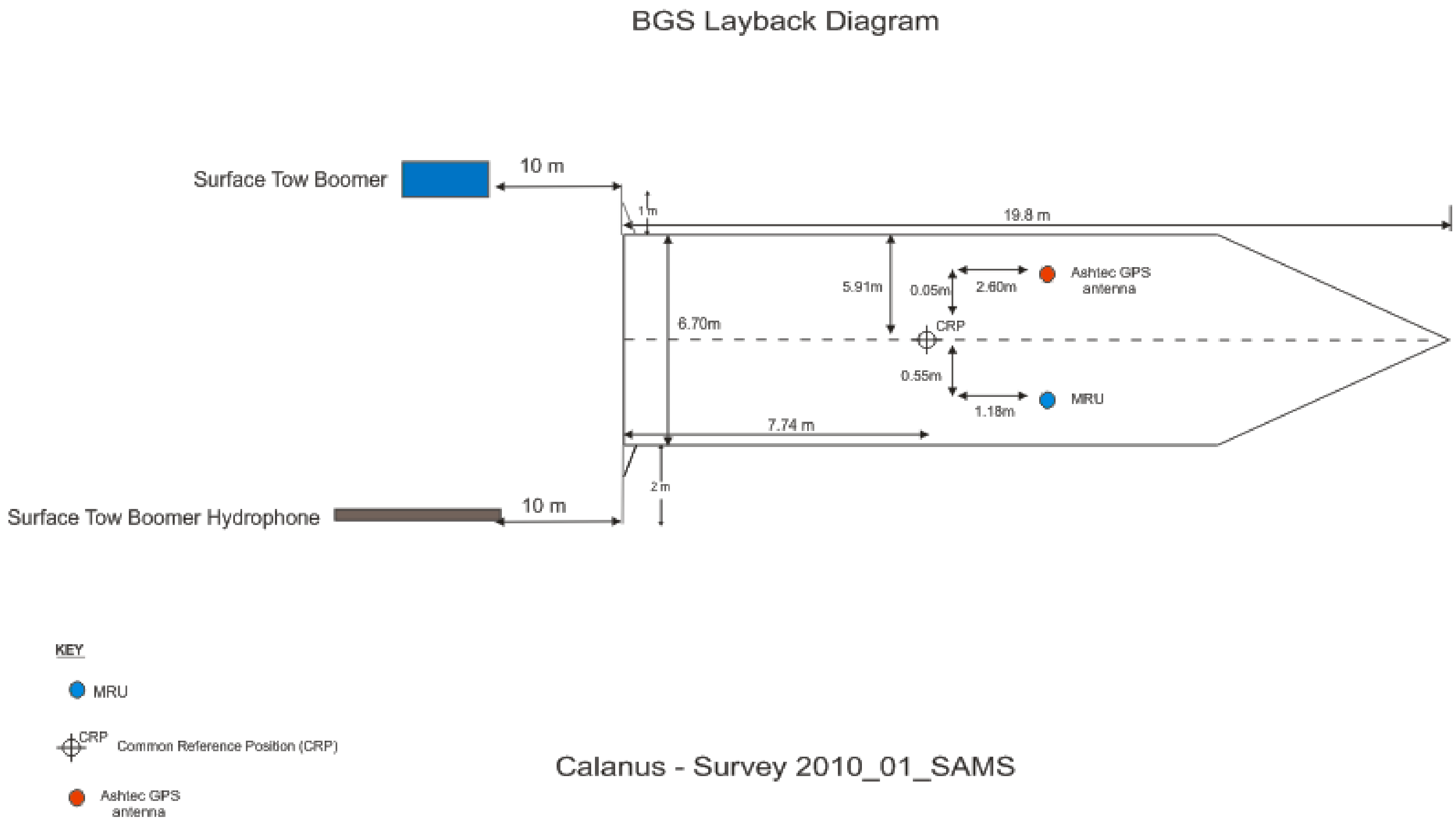
The health and safety guidance for this project was written and approved by BGS prior to operations being undertaken. All BGS personnel read the H&S document and signed the confirmation sheet, the full H&S documentation was also passed around the scientists and crew members involved in the project to read and sign.

All scientists and BGS personnel attended a safety briefing on route to the first survey site on the 12th of January 2010. Muster stations were highlighted and fire procedures were explained with lifeboats assigned to crew and BGS personnel.

All crew, scientists and BGS personnel were required to wear hardhats and protective footwear when at the stern of the vessel deploying and recovering equipment.

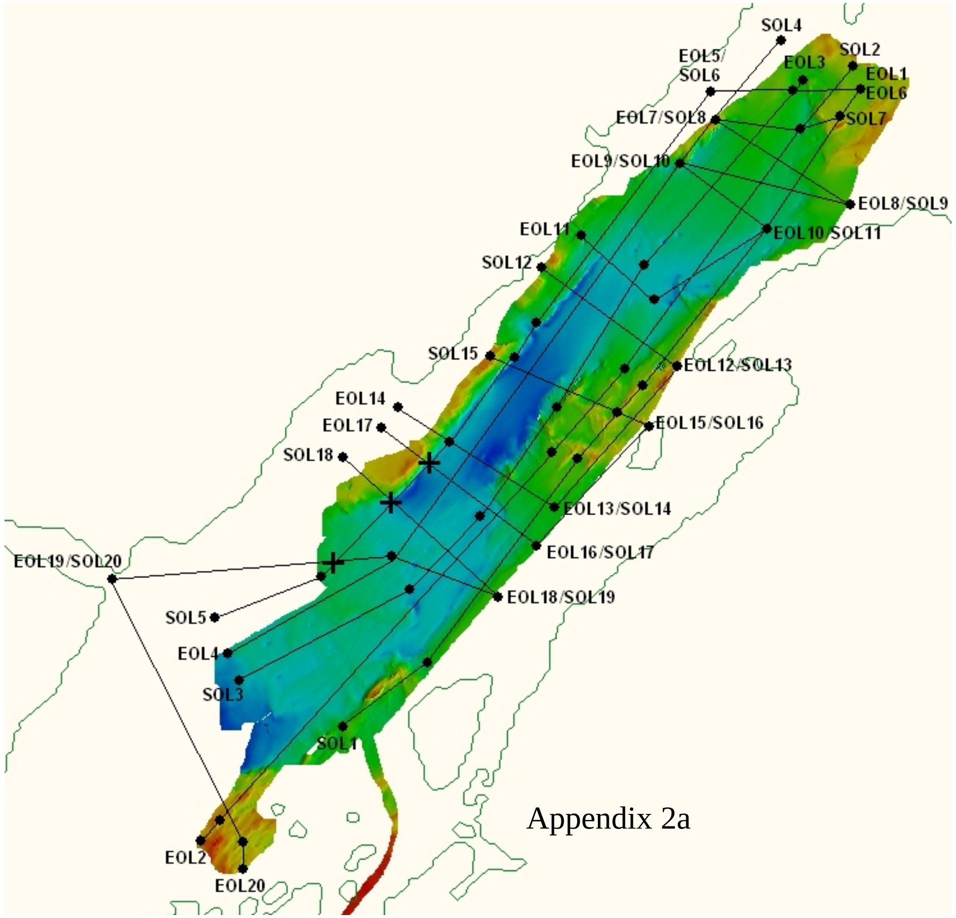
The source of a full health and safety document can be found in appendix 4.

6. Appendix 1 Equipment Layback Diagram



7. Appendix 2 Survey Line numbering

The line numbers shown in the figure below were for planning purposes only. Actual run line numbers are shown in the table alongside the planning numbers.



Appendix 2a

Actual run lines 2010	Planning line numbers 2009
1	1
2	2
3	3
4	4
5	18
6	19
7	20
8	5
9	6
10	7
11	8
12	9
13	10
14	11
15	12
16	13
17	14
18	17
19	16
20	15

Appendix 2b

Appendix 2a: Bathymetry and planned lines from the multibeam survey ran by SAMS in 2009.

Appendix 2b: How the planning line numbers from the 2009 survey relate to the actual line numbers run in this survey.

8. Appendix 3 Personnel

John Howe (SAMS) Party leader

Kate McIntyre (SAMS): PhD student

Michael Wilson: Surveyor/Electrical Engineer

Nick Smart: Surveyor

9. Appendix 4 Health and Safety documentation

H&S and Risk Assessment forms can be found at the following location:

Z:\ProjectInformation\H&S\Offshore\2010\H&S-LochLinne-Calanus

10. References

ADU3 Operation and Reference Manual. Ashtech support FTP site, accessed January 2010. www.ashtech.com