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Marine Geophysical Data - Digital Capture of Paper Records

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Marine Geophysical Data - Digital Capture of Paper Records

Robert Cooke, Joe Bulat, Geoff Christie

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Mary Mowat

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British Geological Survey offices

BGS Central Enquiries Desk

Tel 0115 936 3143 Fax 0115 936 3276

email enquiries@bgs.ac.uk

Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG

Tel 0115 936 3241 Fax 0115 936 3488

email sales@bgs.ac.uk

Murchison House, West Mains Road, Edinburgh EH9 3LA

Tel 0131 667 1000 Fax 0131 668 2683

email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road, London SW7 5BD

Tel 020 7589 4090 Fax 020 7584 8270

Tel 020 7942 5344/45 email bgslondon@bgs.ac.uk

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff CF15 7NE

Tel 029 2052 1962 Fax 029 2052 1963

Forde House, Park Five Business Centre, Harrier Way, Sowton EX2 7HU

Tel 01392 445271 Fax 01392 445371

Maclean Building, Crowmarsh Gifford, Wallingford OX10 8BB

Tel 01491 838800 Fax 01491 692345

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast BT9 5BF

Tel 028 9038 8462 Fax 028 9038 8461

www.bgs.ac.uk/gsni/

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU

Tel 01793 411500 Fax 01793 411501

www.nerc.ac.uk

Website www.bgs.ac.uk

Shop online at www.geologyshop.com

Foreword

This report describes the various types of marine geophysical paper records held by the British Geological Survey (BGS) and the procedures involved in scanning them. The purpose of this report is to provide scanner operators with clear instructions on how to scan the different types of records. It also provides a useful overview to BGS marine and data staff of the records and gives a description and indication of suitability for conversion to SEG-Y for each type. The report includes information on time and effort involved in the digital capture of the records which is intended to assist project leaders with project planning.

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Summary

This report is the first in a series of two reports related to the digital capture of geophysical records.

This report describes the types of BGS Coastal and Marine analogue geophysical records and the techniques involved in scanning them in order to produce the highest possible quality TIFF image files.

It is possible to convert scanned geophysical images into digital data which then can used for seismic interpretation with packages such as the Landmark system which is used in BGS. SEG-Y is the standard data format used for this. The conversion of geophysical images to digital SEG-Y files and the software used in processing is described in detail in a second report (Cooke et al., 2012. IR/12/061).

Primarily between 1967 and 1992 data were recorded on paper only and as these records are deteriorating it is necessary to capture them digitally to preserve them for long term. The main part of the report introduces the history of the records obtained and provides comprehensive instructions for carrying out the scanning of the paper records.

Appendix 1 presents examples and describes each of the geophysical record types and media and gives an indication of their potential to be converted to SEG-Y. This provides a useful overview of the records to staff involved with scanning the records and also to other BGS staff.

The types of geophysical records held include seismic profiles (Airgun, Sparker, Boomer and Pinger), Echo Sounder and Sonar (Sidescan Sonar and Transit Sonar). The records are held on various types of paper media such as tissue paper, white rolled paper, carbon type paper and graph type paper which are of varying quality and some have deteriorated to varying degrees with the passing of time. The records are often long and constant monitoring is usually required during the scanning process as the records are prone to drifting and twisting. The records are normally scanned in sections of 300 inches.

The conversion of TIFF files into SEG-Y files is only appropriate for some combinations of seismic profile record type and media and the record must be of good quality. The conversion process is highly manual, time consuming and requires a trained operator.

Generally good quality airgun and sparker records are most suitable for conversion to SEG-Y. High quality Boomer and Pinger records may also be processed but this requires much more time and therefore is expensive and requires careful consideration.

It is anticipated that eventually all paper seismic profiles will be captured as graphical bitmaps. As the additional conversion to SEG-Y is time consuming this will only be undertaken when specifically authorised for individual projects.

1 Introduction

BGS geophysical data acquired between 1967 and 1992 were recorded on paper records only. As there are no digital files associated with these records it is vital that they are digitally captured in order to safeguard their long term preservation. After 1992 digital geophysical data were also routinely collected in addition to the paper records, though there are also some later records where no digital data exists.

The data consist predominately of reflection seismic profiles shot with a variety of seismic source types of different frequency bandwidths. These include Airgun, Sparker, Boomer (both deep and shallow tow) and Pinger. Other types of geophysical records such as Echo Sounder, Sidescan Sonar and Transit Sonar records are also held.

BGS hold an estimated 20000 paper records in the marine geophysics collection which is stored in Murchison House and Keyworth as part of the National Geological Records Centre (NGRC). Approximately 10% of these have already been scanned (as of October 2010). Currently the records are normally scanned as required for customer enquiries or on behalf of BGS marine staff working in a particular area of interest.

The earliest seismic profiles were recorded using wet-paper facsimile recorders. Thin chemically treated paper was exposed to varying electrical discharges and would then be passed through a chemical bath to fix the record. The paper would tend to wrinkle once dry and the records have faded with a distinct sepia colour cast.

Later recording technology from the mid-1970s, such as EPC recorders, employed dry technologies where an electrostatic charge burned chemically treated paper to produce the geophysical profile. The resulting paper record is free of wrinkle distortions and has preserved its original colour better.

From the late 1980s thermal printers replaced the EPC technology. The thermal printers use a very stable plastic medium that produce records that are resistant to fade.

All three recording technologies produce a variable density trace seismic record (Figure 1, left panel). In variable area display of seismic data, amplitudes are represented by greyscale colour on a vertical trace. In this case maximum positive values are black and minimum negative values are white. Zero values are mid-grey. This display method is commonly used for BGS single channel seismic paper records.

Variable area display is quite different from wiggle trace display (Figure 1, right panel) which is a common display type for commercial multichannel seismic paper sections. Amplitudes are represented by a wiggle trace with positive values displacing the curve to the right and negative to the left. In addition, the positive values are given a solid black colour beneath the curve. This additional amplitude information cannot be obtained from variable density records.

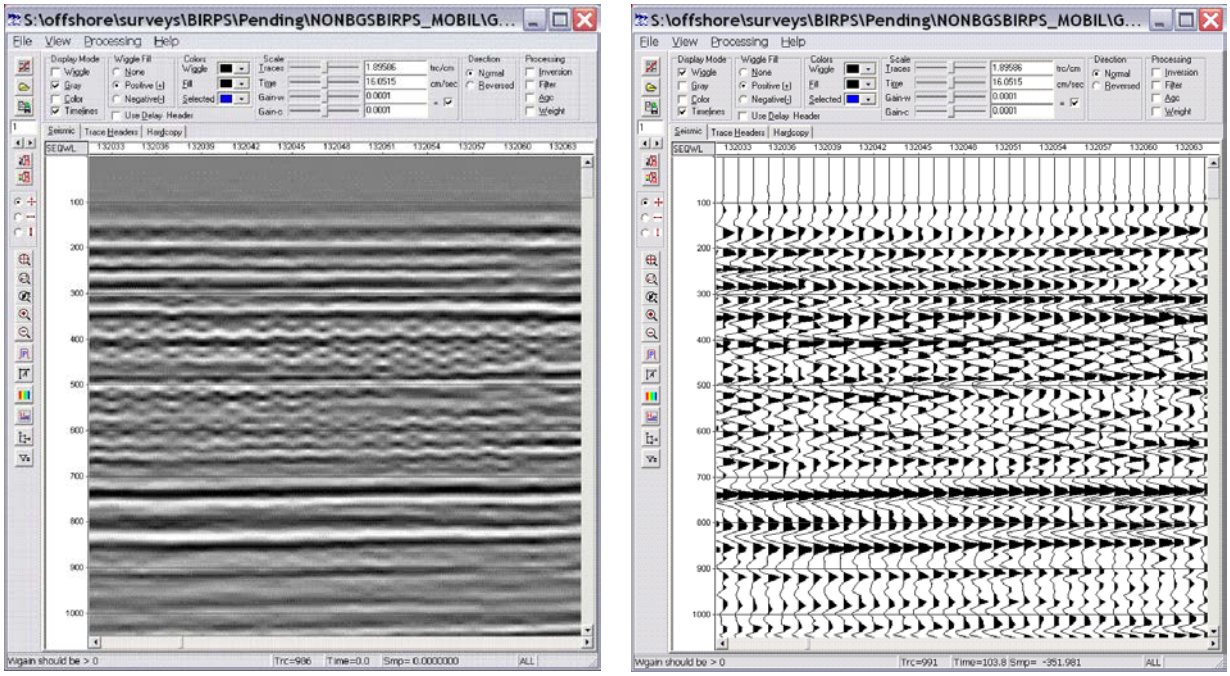


Figure 1 Comparison of variable area display (left), commonly used for BGS seismic paper records, and wiggle trace display (right) of the same data

The paper records are stored as roles of paper and are physically very long. The older paper records have deteriorated with time, showing signs of fading and brittleness, so creating a digital replication of these data is of high priority. This report describes the initial graphical scanning of the paper records into a standard bitmap format (i.e. uncompressed tif). TIFF is a common type of bitmap image format and is the standard recommended archival format for storing images in BGS. This is done using existing scanning facilities in Murchison House and Keyworth.

The scanning has to be of sufficient quality that the bitmap can subsequently be used to convert the bitmap graphic into a standard geophysical exchange format for seismic data, i.e. a SEG-Y file. SEG-Y is a standard data format developed by the Society of Exploration Geophysicists for exchanging seismic data. It is commonly used within industry and can be used within seismic interpretation packages.

The seismic records are held on various types of paper media and not all of these are suitable for conversion to SEG-Y. If the quality of the original record is not good, it will not be possible to convert it. It must be clearly legible with good contrast and free from distortion. The vertical navigational fix marks, horizontal two-way time lines and manual annotations (particularly line and fix numbering) must all be clearly visible. Airgun and Sparker records on white rolled paper are the most appropriate for conversion to SEG-Y as these records are generally of uniform black and white colour. Some other types of record such as Boomer and Pinger may be SEG-Y compatible, but with complications and are significantly more time consuming to process.

The second phase of the process is the conversion of the bitmap graphic to SEG-Y format and the procedure for this is described in detail in a second report (Cooke et al., 2012. IR/12/061). This is done using the UNIX program Cameleo (Seistran), (Miles, et al., 2007) and further processing of the SEG-Y using ProMAX for the removal of artefacts and standardisation of the record. This second phase is essential for importing these data into geophysical interpretation facilities such as Landmarks's SeisWorks or Geographix that require standard SEG-Y files. The licence for Seistran is quite expensive and BGS currently has one licence. The process is highly manual, time consuming and requires a trained operator.

It is anticipated that eventually all paper seismic profiles will be captured as graphical bitmaps. This is to ensure the deteriorating records are captured and digitally archived for the long term preservation of their content. As the additional conversion to SEG-Y is time consuming this will only be undertaken when specifically authorized for individual projects.

A summary of the different types of paper records is given in Table 1. To give an indication of the time involved in creating SEG-Y files and their resulting file sizes (for 100 fixes) a summary of the geophysical record and media types is presented in Table 2.

Geophysical Record Type	**Type of Media**	**Suitable for conversion to SEG-Y?**
Sparker	Tissue Paper Media	No
Sparker	White Rolled Paper Media	Generally if good quality
Boomer	White Rolled Paper Media	Potentially, but with complications
Boomer	Tissue Paper Media	No
Airgun	White Rolled Paper Media	Generally if good quality
Pinger	Tissue paper media	No
Pinger	White rolled paper media	Potentially, but with complications
Pinger	White folded paper media	Potentially, but with complications
Echo Sounder	Narrow curved trace on carbon type paper media	No
Echo Sounder	Graph type paper media	No
Sidescan Sonar	White rolled paper media	No
Sidescan Sonar	Tissue paper media	No
Transit Sonar records	Tissue paper media	No

Table 1 Summary of Geophysical Record and Media Types

Geophysical Record Type	**Suitable for conversion to SEG-Y?**	**Estimated time involved to process 100 fixes to SEG-Y**	**Final SEG-Y file size**
Airgun	Yes	3 – 4 hours	16.4 MB
Sparker	Yes	7 – 8 hours	72.8 MB
Boomer	Potentially, but with complications	8 – 9 hours	740 MB
Pinger	Potentially, but with complications	15 -16 hours	5.24 GB

Table 2 Summary of Geophysical Record Types

2 Scanning of Paper Records

Paper records should be scanned either at 300dpi as Greyscale images or 600 dpi as Greyscale images. The decision tree below (Figure 2) indicates which setting to employ.

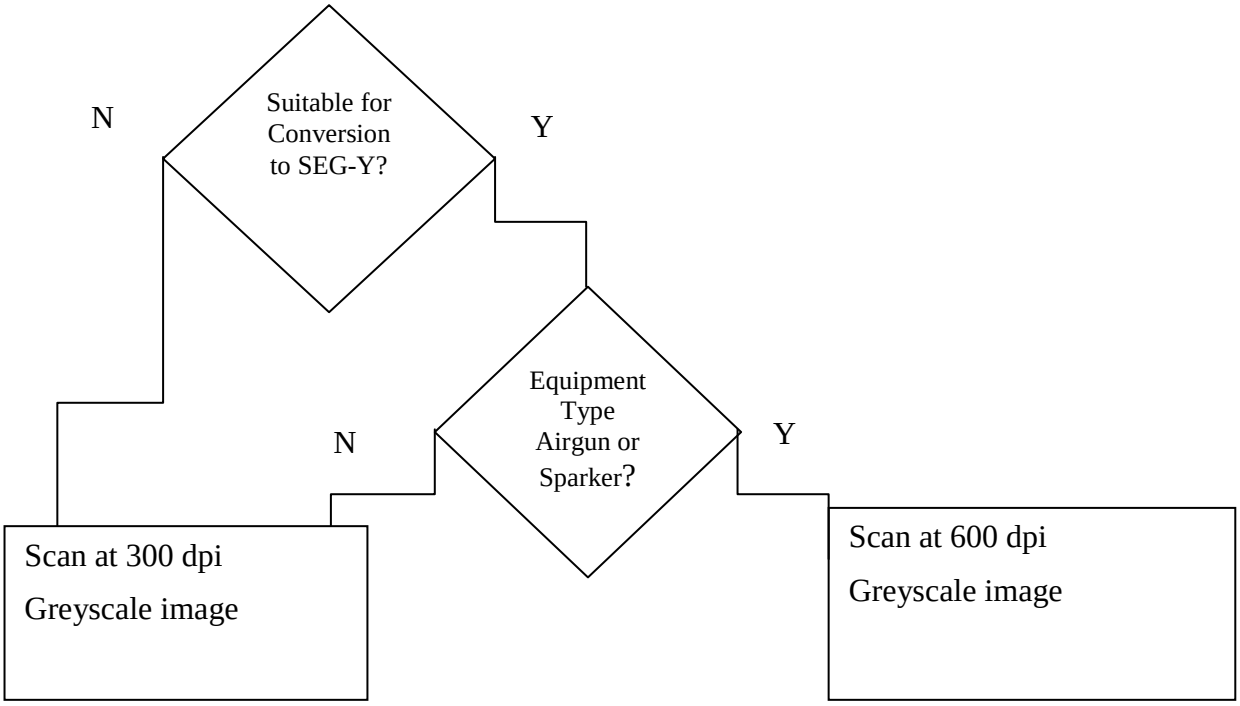


Figure 2 Decision tree for scanning options

Only reflection seismic profiles can meaningfully be converted to SEG-Y. The following data types are reflection seismic profiles:

- Airgun
- Sparker
- Boomer (both deep-tow and surface tow)
- Pinger

They differ only in the dominant frequency of the seismic source. As Airgun and Sparker are more likely to require conversion to SEG-Y at some future date they should be scanned at 600 dpi as Greyscale images if they are of good quality. A paper record is considered of good quality if:

- Consists of a heavier paper in good condition (not torn or too brittle)
- Paper not wrinkled or heavily distorted
- Good contrast black and white record
- Clear two-way time and navigation fix lines (see Fig 3 for example)
- Legible annotation and side panel information

Figure 3 shows an example good quality paper record from the 1980s that has been scanned. All the annotation and side panel information is clearly legible. The seismic record is clear as well as the vertical navigational fix marks and horizontal two-way time lines.

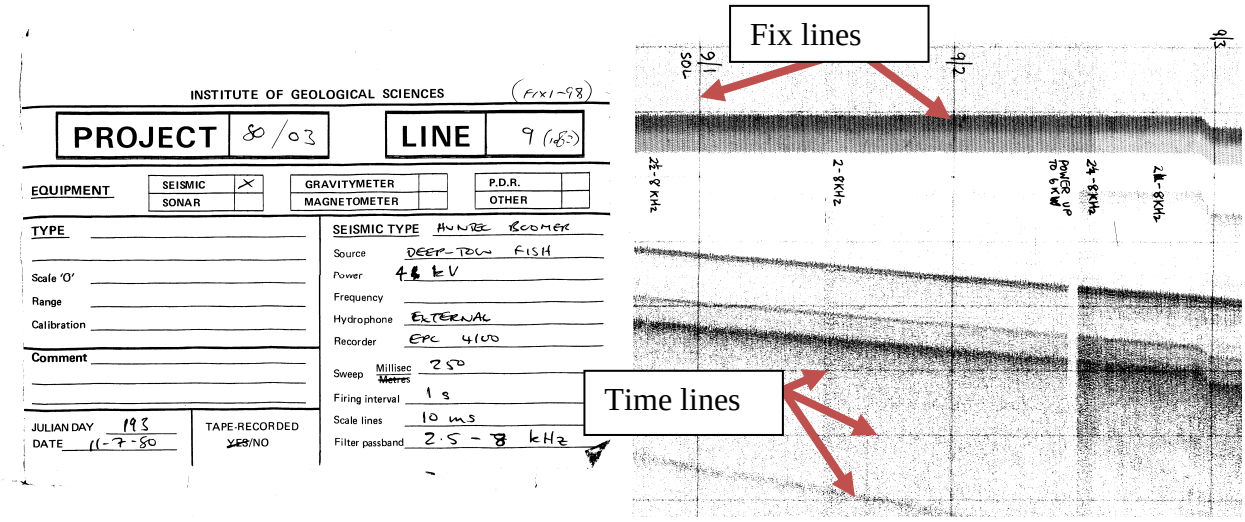


Figure 3 Example boomer record showing side panel, navigational fixes (vertical lines), two-way time lines (horizontal lines) and sundry manual annotation.

In general the "wet-paper" records dating from the late 1960s are too distorted and wrinkled (see Figure 4) and will fail the above criteria.

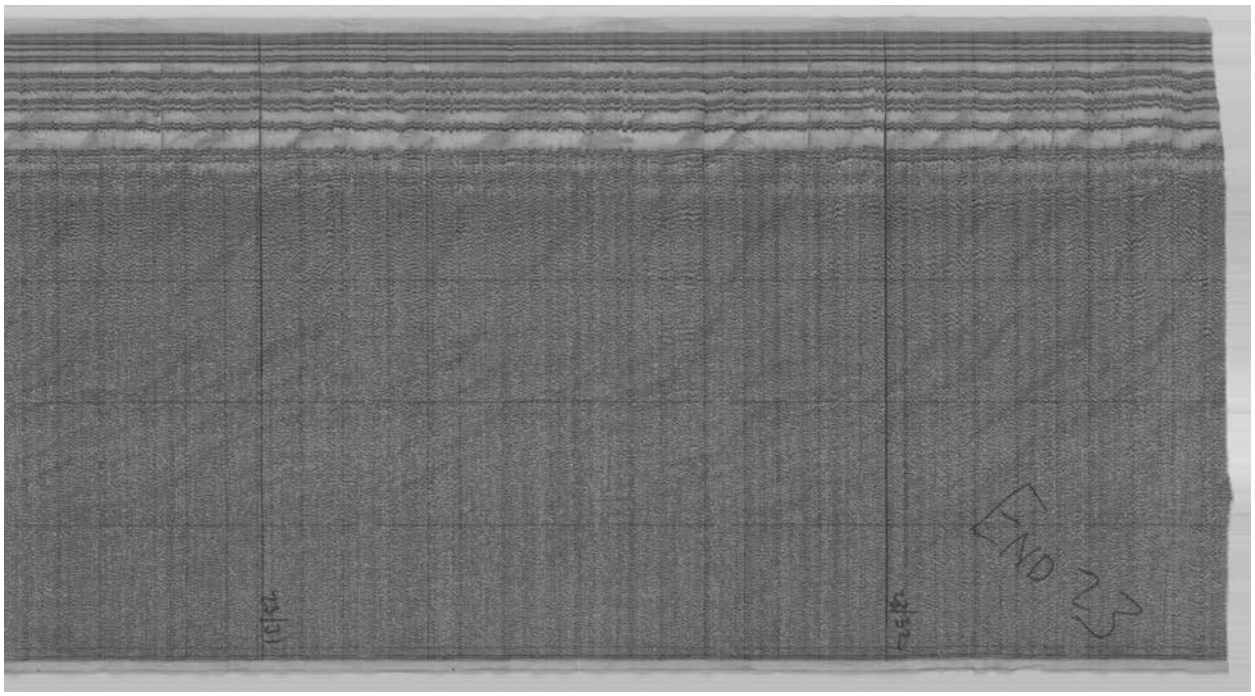


Figure 4 Example Sparker line from 1968 of 'wet-paper' record with pronounced wrinkles overprinting the data and distorted time and fix lines.

If the paper record fails these criteria it should be scanned at 300 dpi as a Greyscale image to preserve as much information as possible. All records of other data types e.g. echo sounder or side-scan should be scanned at 300dpi and Greyscale, to ensure best data capture.

2.1 SCANNING 600DPI GREYSCALE

Launch Scanworks on Scanning computer attached to rotary scanner Colortrac 4280.

Select Data Control;

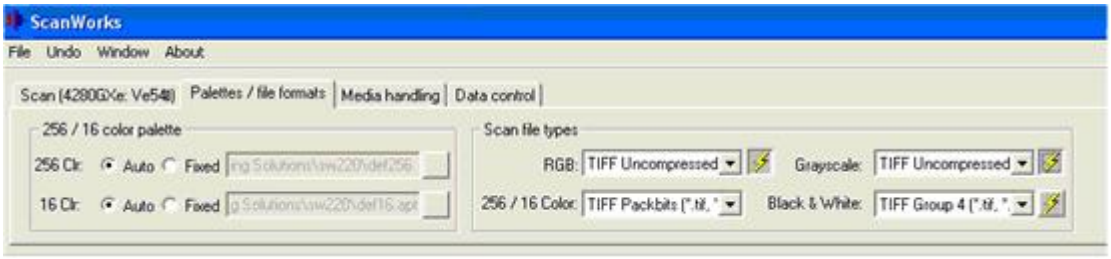
- Only the brightness setting may require adjustment. 7 should be ideal.

Select Media Handling;

- End of scan behaviour;
  - Ensure "so nothing on save/delete" is selected.
  - Version 2.4.7.6 does not allow control over the “Auto detect end of media” feature. This can mean the scan can stop unexpectedly. Version 2.2.0 does allow this control, so ensure "Auto detect end of media" is not ticked. This will prevent the scan stopping unexpectedly.
- Justification;
  - Select "centre".
- Staging;
  - Nothing can be changed under this setting in version 2.4.7.6, but in version 2.2.0 both values should be set to 0.
- Speed;
  - Set to 7 or 8. Speed 7 is significantly slower than 8 but may be more controllable on certain media.
- Auto load delay;
  - Should be set to 0 or 1, this controls how long the record must be held at the machine before the scanner feeds it in.

Select File Formats;

- Ensure Greyscale is set to TIFF Uncompressed and that the "Lightning" button is depressed.



Select Scan Settings;

- Set resolution to 600dpi and datatype to Greyscale. Due to hardware limitations on the 4280 scanner this is interpolated from an optical 400dpi.
- Measure width of record to be scanned - allow an extra inch on either side of the record to ensure no data are lost if the record drifts off-centre.
- Choose "specify" in the sizes dialogue, and populate the width and height. Set the height to 300 inches (maximum length of record which can be scanned without the software crashing).
- Set the destination folder to:
  W:\Teams\IMFO\CMDB\Data\SeismicRecordsData\Scanned_BGS_SeismicLines
  (note that this current location is temporary, pending integration into the Corporate Survey Data Store)
- Filename structure as described in the Marine Survey Data Management Handbook (Crummy, 2009) is;

  [year]_[project]_[equipment type]_Line[x]_Fix[y]-[z]_BW.tif

  eg. 1980_4_BM_Line20_Fix25-40_BW.tif

Place the leading edge acetate template onto the scanner. Fit the record to be scanned into the leading edge template centring it onto the scanner. Feed the leading edge into the rotary scanner and the record will automatically be loaded. Ensure it is loaded without any twisting.

Click the start scan button (or press F9).

The paper records are long and thin and may not be evenly drawn into the rotary scanner due to slip between the rubber wheels in the scanner and the document. This will result in a perceptible movement or drift of the document relative to the scanner. The drift will impart a noticeable subtle wavy distortion in the time lines and also cause the fix lines to be distorted out of the vertical in the scanned image. Such distortions are highly undesirable when converting to SEG-Y and must be minimised. Constantly monitor the record as it is being drawn into the scanner ensure that it does not drift. Use the ruler printed on the scanner to keep drift below 5mm from the starting point. When the scan is complete click the stop button (or press F10).

If the record is longer than 300 inches the scanner will stop when it reaches this length. At this point save the scan and rename the file to the scanned fix range. Rewind the record to the last fix

scanned to ensure an overlap and adjust the filename accordingly. Resume scanning of the remainder of the record. Repeat this as necessary.

2.1.1 Assess Image Quality

Scan down the record and check for acceptable contrast/brightness/threshold and adjust as required, then save. Ensure the record does not show too high drift, and that nothing has been cut off at the sides.

It is critical that the following are clearly visible:

- Time lines (regular lines on the record parallel to the direction of scanning)
- Fix lines (regular vertical lines on the record)
- Manual annotations, particularly line and fix numbering
- Side-Panel/Record Header information
- Check that the Time lines are straight and not wavy

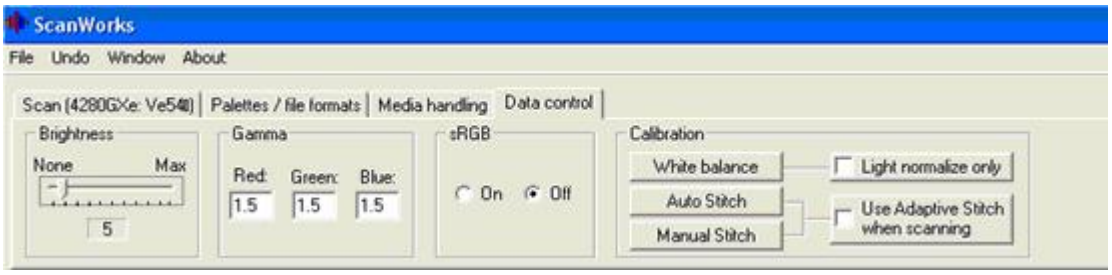
Adjust the Post-scan contrast and threshold settings until the features listed above can be seen clearly.

2.2 SCANNING 300DPI GREYSCALE

Launch Scanworks on Scanning computer attached to rotary scanner Colortrac 4280.

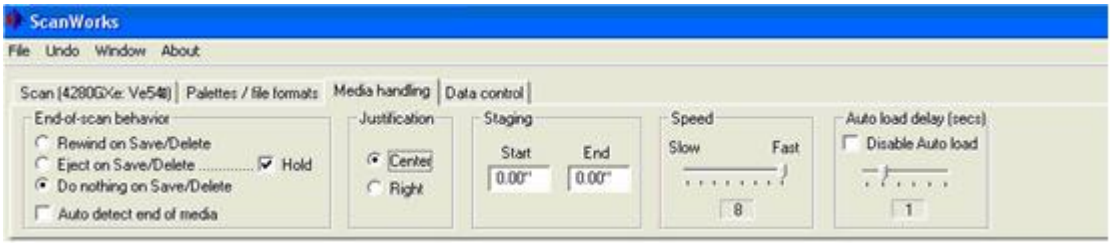
Select Data Control;

- Only the brightness setting may require adjustment. 7 should be ideal.



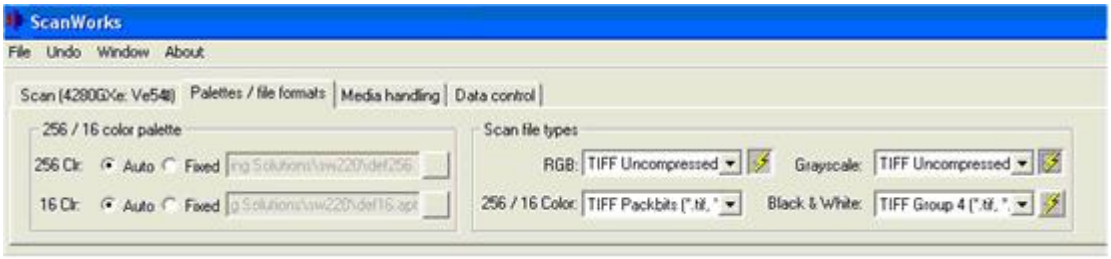
Select Media Handling;

- End of scan behaviour;
  - Ensure "so nothing on save/delete" is selected.
  - Version 2.4.7.6 does not allow control over the “Auto detect end of media” feature. This can mean the scan can stop unexpectedly. Version 2.2.0 does allow this control, so ensure "Auto detect end of media" is not ticked. This will prevent the scan stopping unexpectedly.
- Justification;
  - Select "centre".
- Staging;
  - Nothing can be changed under this setting in version 2.4.7.6, but in version 2.2.0 both values should be set to 0.
- Speed;
  - Set to 7 or 8. Speed 7 is significantly slower than 8 but may be more controllable on certain media.
- Auto load delay;
  - Should be set to 0 or 1, this controls how long the record must be held at the machine before the scanner feeds it in.



Select File Formats;

- Ensure Greyscale is set to TIFF Uncompressed and that the "Lightning" button is depressed.



Select Scan Settings;

- Set resolution to 300dpi and datatype to Greyscale.
- Measure width of record to be scanned - allow an extra inch on either side of the record to ensure no data are lost if the record drifts off-centre.
- Choose "specify" in the sizes dialogue, and populate the width and height. Set the height to 300 inches (maximum length of record which can be scanned without the software crashing).
- Set the destination folder to:
  W:\Teams\IMFO\CMDB\Data\SeismicRecordsData\Scanned_BGS_SeismicLines
  (note that this is current location is temporary, pending integration into the Corporate Survey Data Store)
- Filename structure as described in the Marine Survey Data Management Handbook (Crummy, 2009) is;

  [year]_[project]_[equipment type]_Line[x]_Fix[y]-[z].tif

  eg. 1980_4_BM_Line20_Fix25-40.tif

Place the leading edge acetate template onto the scanner. Fit the record to be scanned into the leading edge template centring it onto the scanner. Feed the leading edge into the scanner and the record will automatically be loaded. Ensure it is loaded without any twisting.

Click the start scan button (or press F9).

As the record is being drawn into the scanner ensure that it does not drift. Use the ruler printed on the scanner to keep drift below 5mm from the starting point. When the scan is complete click the stop button (or press F10).

If the record is longer than 300 inches the scanner will stop when it reaches this length. At this point save the scan and rename the file to the scanned fix range. Rewind the record to the last fix scanned to ensure an overlap and adjust the filename accordingly. Resume scanning of the remainder of the record. Repeat this as necessary.

2.2.1 Assess Image Quality

Scan down the record and check for acceptable contrast/brightness/threshold and adjust as required, then save. It is important that the following features are visible in the scan as far as the original will permit:

- Time lines (regular lines on the record parallel to the direction of scanning)
- Fix lines (regular vertical lines on the record)
- Manual annotations, particularly line and fix numbering

Ensure the record does show too high drift, and that nothing has been cut off at the sides.

Appendix 1 Geophysical Record Types

The seismic paper records collection has several different paper types/formats and the settings for processing them will depend on what type/format is used.

Records that are classified as SEG-Y Compatible are Sparker or Airgun seismic records which are of good enough quality to undergo the Cameleo (Seistran) process. These records generally are of uniform black and white colour, printed upon reasonably heavy, rather than flimsy paper. Provided the data are not faded and time lines are visible, these records should be scanned at 600dpi and Greyscale.

Boomer and Pinger records of a similar quality can be processed, but this takes significantly more time and are therefore is more expensive. Before processing these records, this consideration should be taken into account.

Records that do not meet these criteria are classified as Not SEG-Y Compatible. These records should be scanned at 300dpi and Greyscale, to ensure best data capture.

SPARKER RECORDS – TISSUE PAPER MEDIA

These records are generally yellow and brown instead of black and white and are also faded. Therefore the scan should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

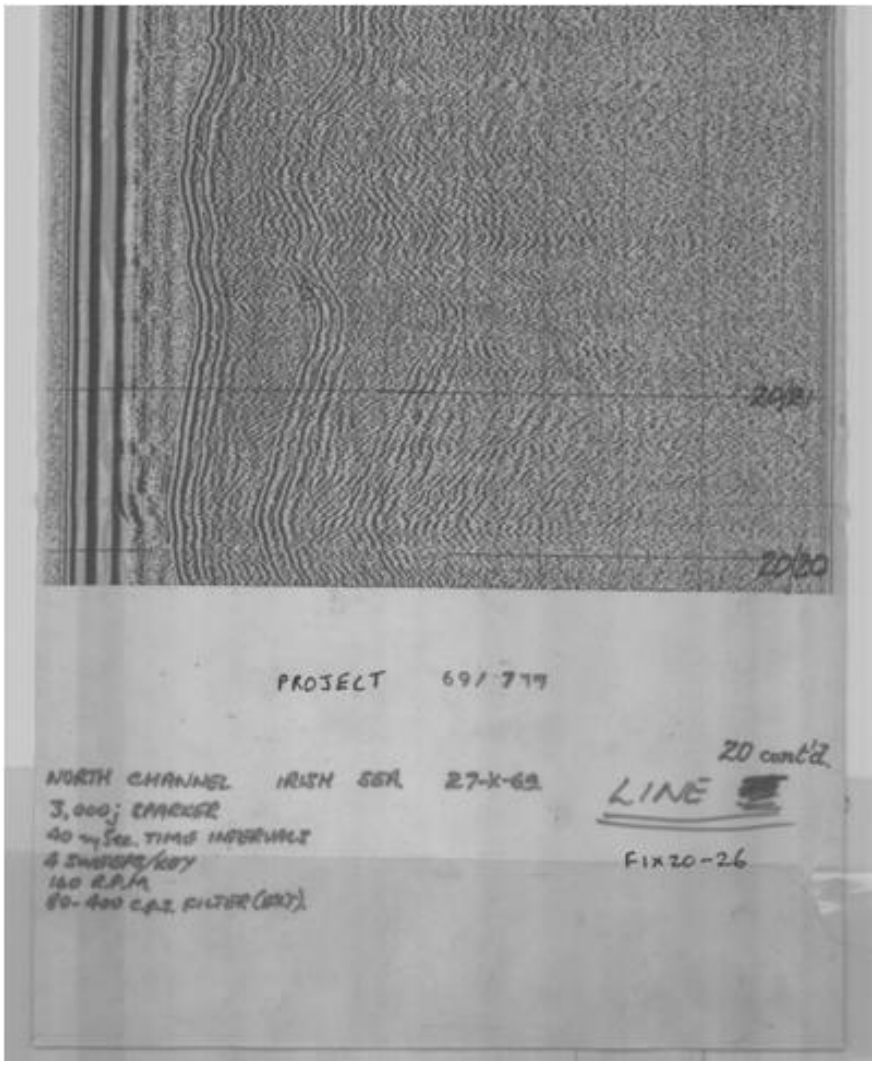


Figure 5 Sparker record on tissue paper media

SPARKER RECORDS - WHITE ROLLED PAPER MEDIA

These records are generally of good quality. Providing the time lines are visible these should be scanned in Greyscale 600 dpi. Otherwise scan in Greyscale 300dpi.

These are prone to drifting during scanning as they are generally long records.

- **Generally SEG-Y Compatible**

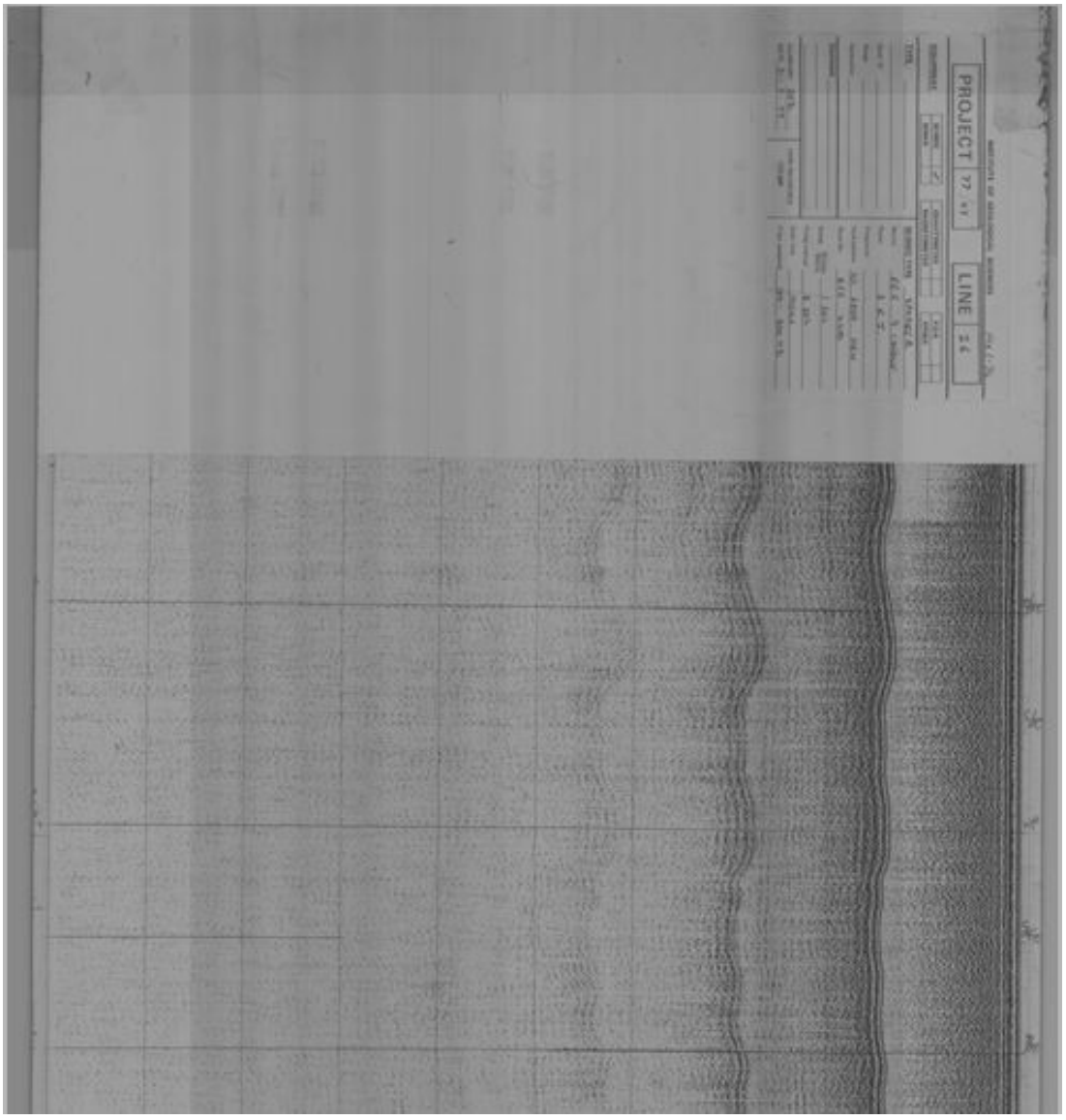


Figure 6 Sparker record on white rolled paper media

BOOMER RECORDS - WHITE ROLLED PAPER MEDIA

These records are usually 1970s or later and generally of good quality. Providing the time lines are visible these should be scanned in Greyscale 600 dpi. Otherwise scan in Greyscale 300dpi.

These are prone to drifting during scanning as they are generally long records.

- **Potentially SEG-Y Compatible, but with complications**

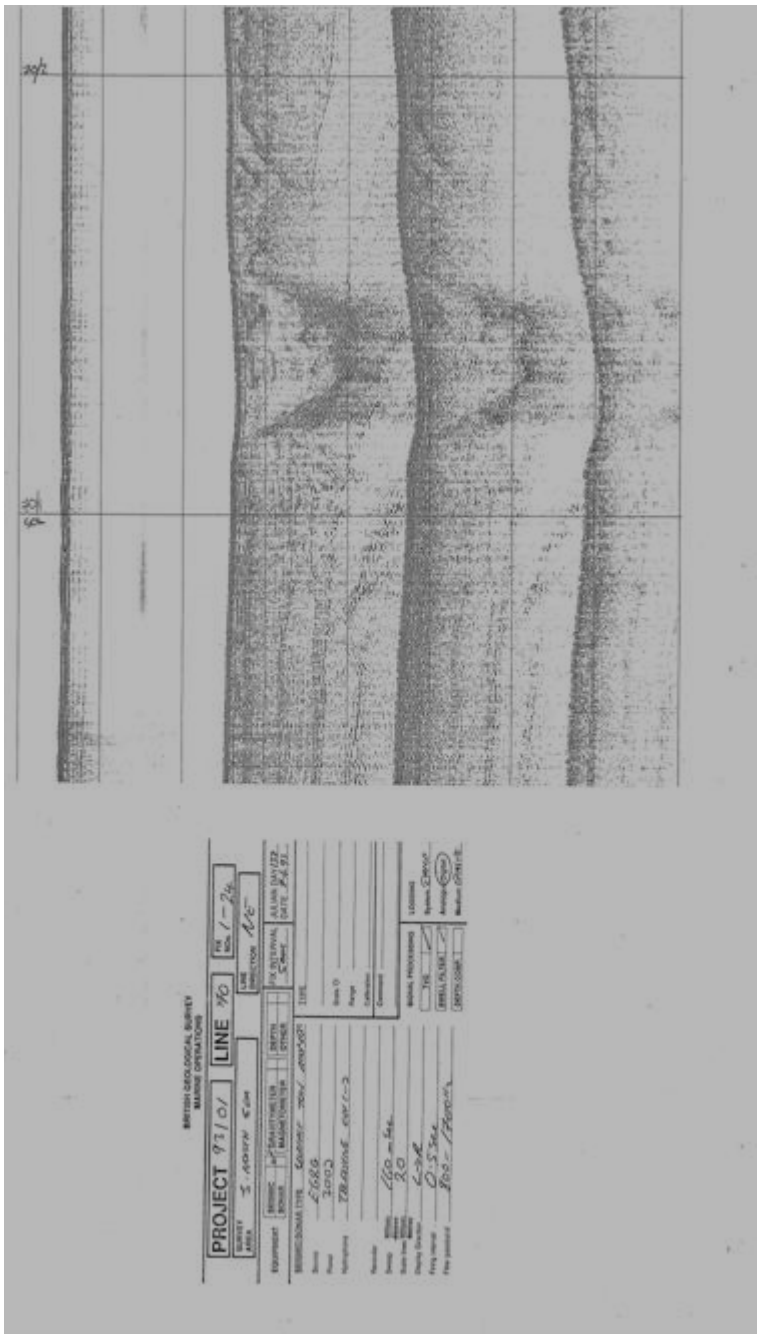


Figure 7 Boomer record on white rolled paper media

BOOMER RECORDS – TISSUE PAPER MEDIA

These records are usually pre 1970 and generally yellow and brown instead of black and white and are also faded. Therefore the scan should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

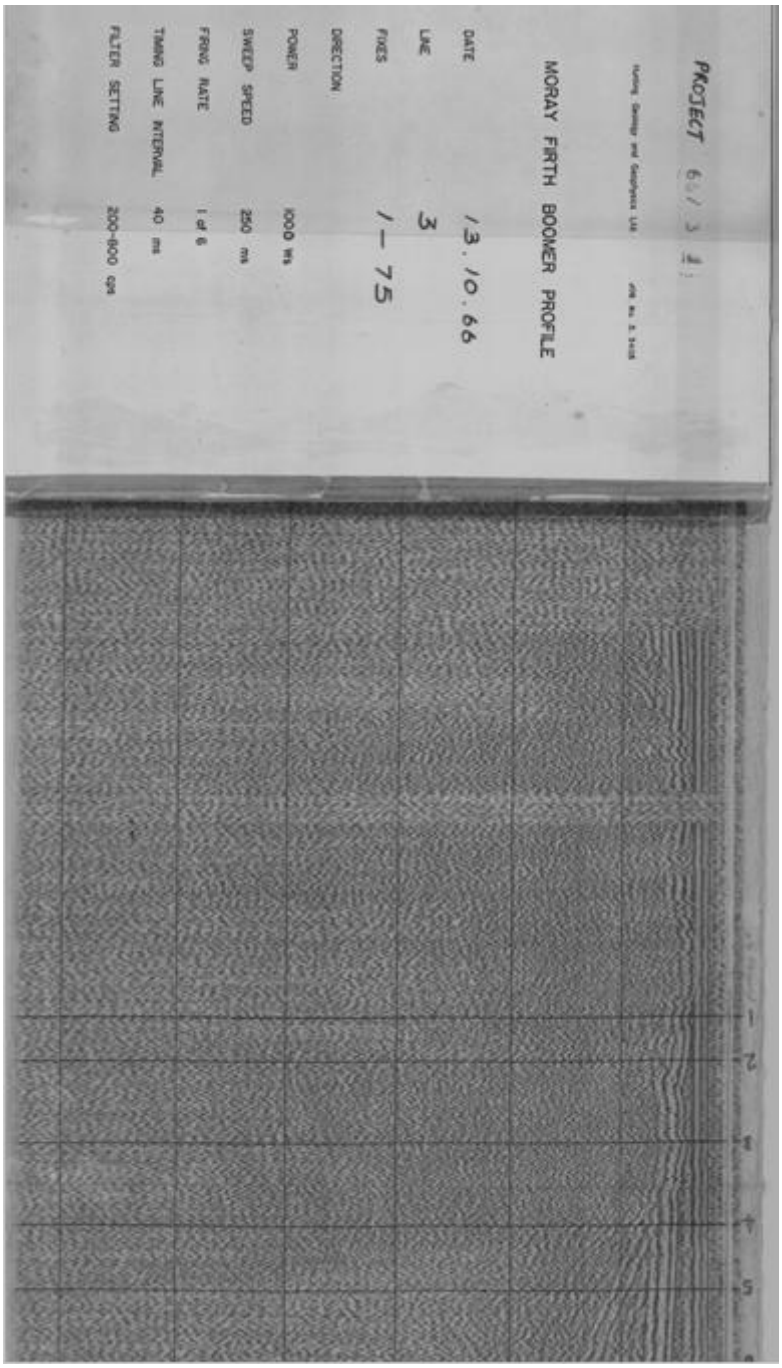


Figure 8 Boomer record on tissue paper media

AIRGUN RECORDS - WHITE ROLLED PAPER MEDIA

These records are generally of good quality. Providing the time lines are visible these should be scanned in Greyscale 600 dpi. Otherwise scan in Greyscale 300 dpi.

These are prone to drifting during scanning as they are generally long records.

- **Generally SEG-Y Compatible**

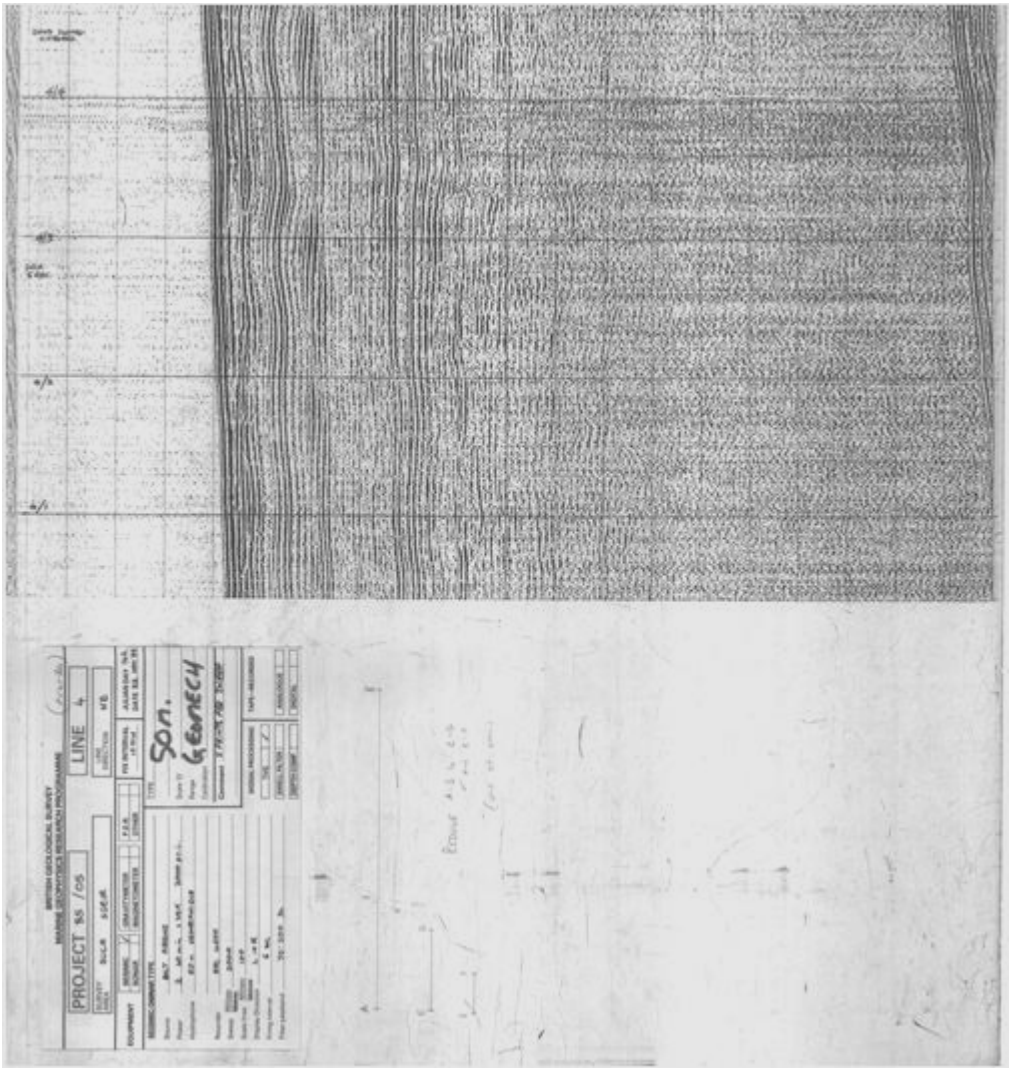


Figure 9 Airgun record on white rolled paper media

PINGER RECORDS – TISSUE PAPER MEDIA

These records are generally yellow and brown instead of black and white and are also faded. Therefore the scan should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

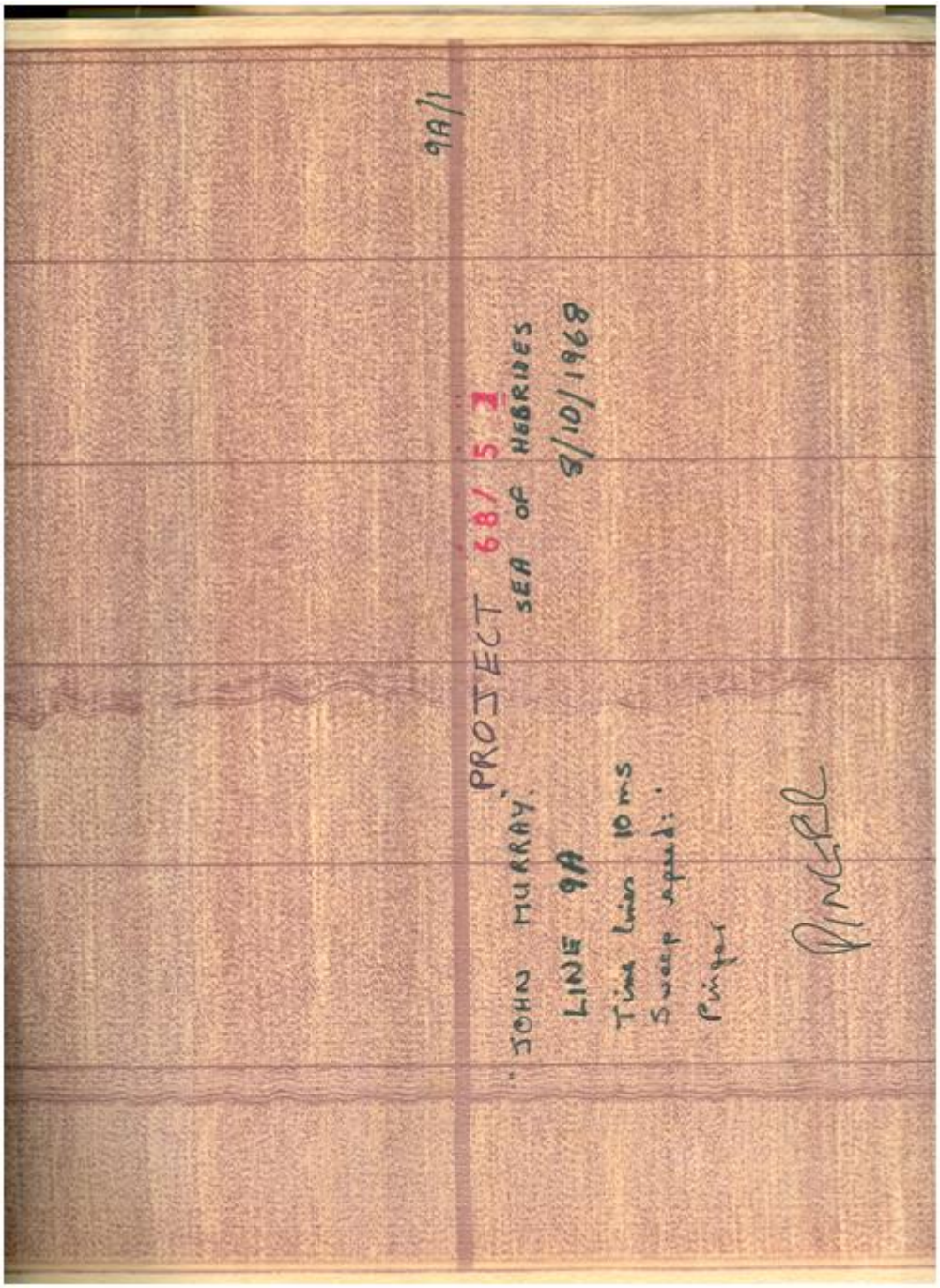


Figure 10 Pinger record on tissue paper media

PINGER RECORDS – WHITE ROLLED PAPER MEDIA

These records are generally of good quality. Providing the time lines are visible these should be scanned in Greyscale 600 dpi. Otherwise scan in Greyscale 300 dpi.

These are prone to drifting during scanning as they are generally long records.

- **Potentially SEG-Y Compatible, but with complications**

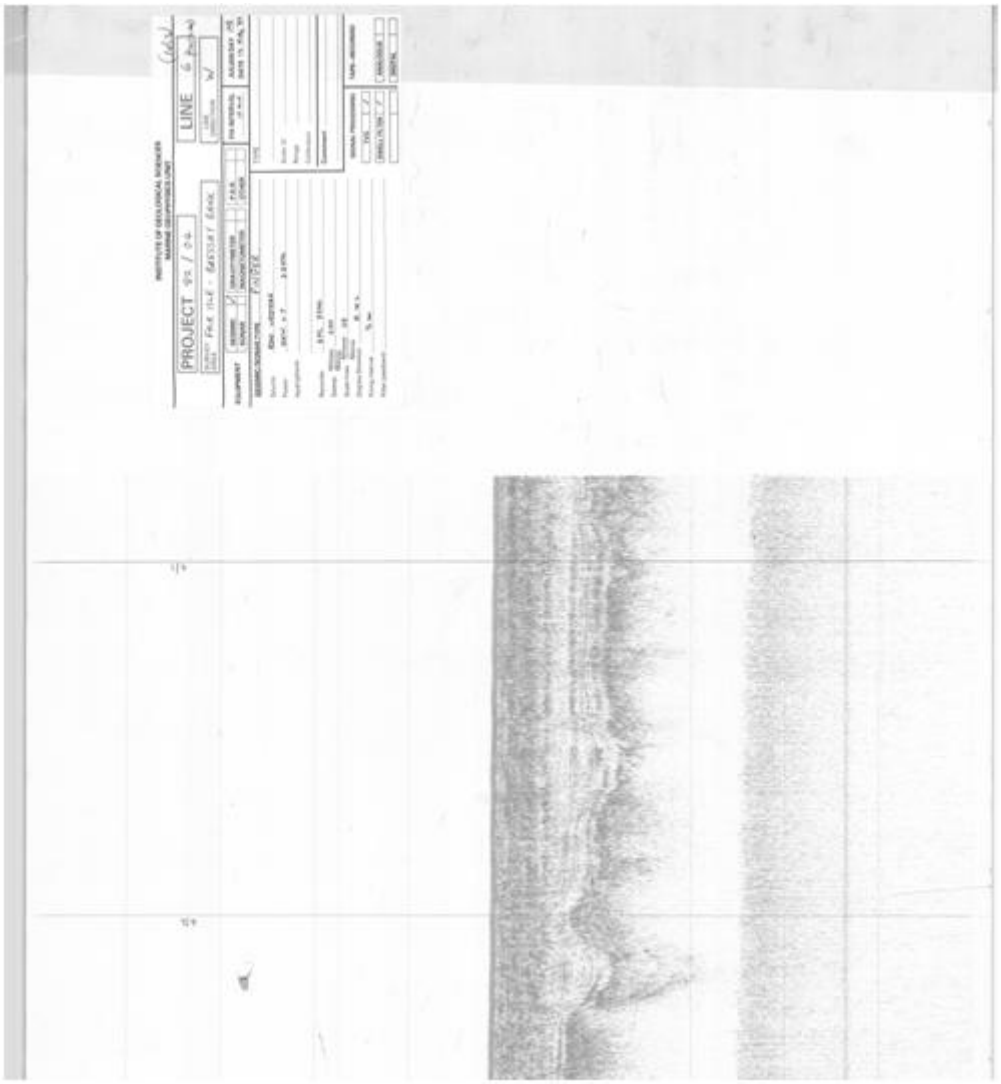


Figure 11 Pinger record on white rolled paper media

PINGER RECORDS – WHITE FOLDED PAPER MEDIA

These records are generally of good quality. Providing the time lines are visible these should be scanned in Greyscale 600 dpi. Otherwise scan in Greyscale 300 dpi.

- **Potentially SEG-Y Compatible, but with complications**

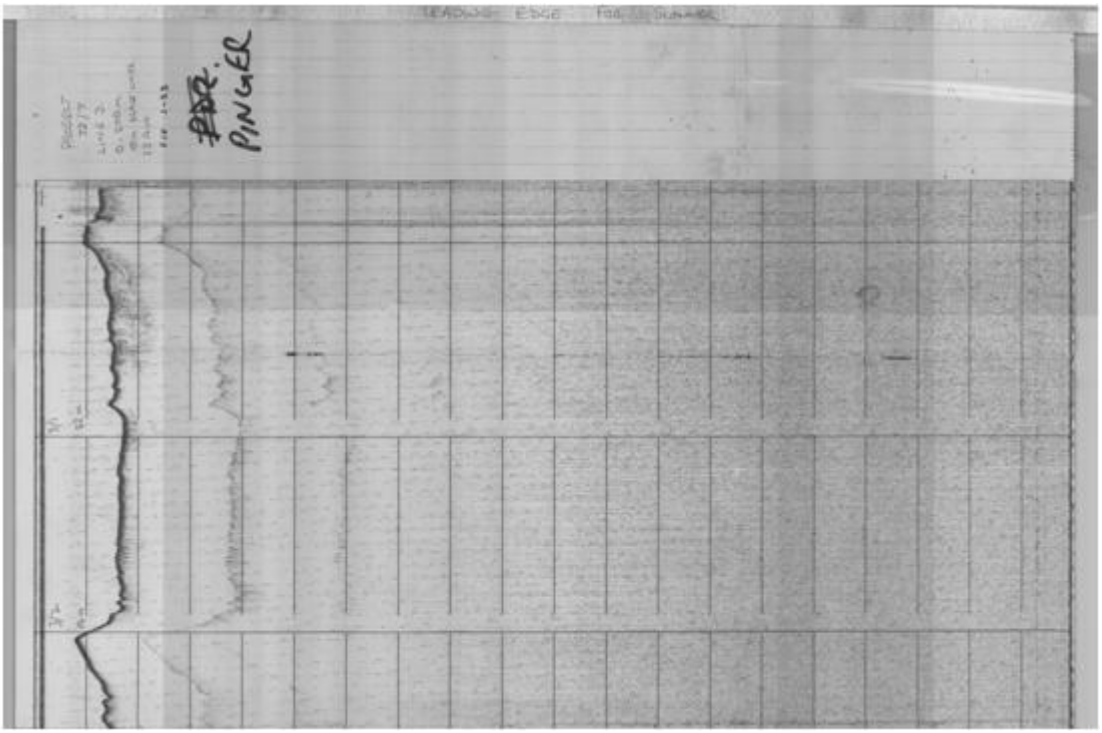


Figure 12 Pinger record on white folded paper media

ECHO SOUNDER RECORDS – NARROW CURVED TRACE ON CARBON TYPE PAPER MEDIA

These scans should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

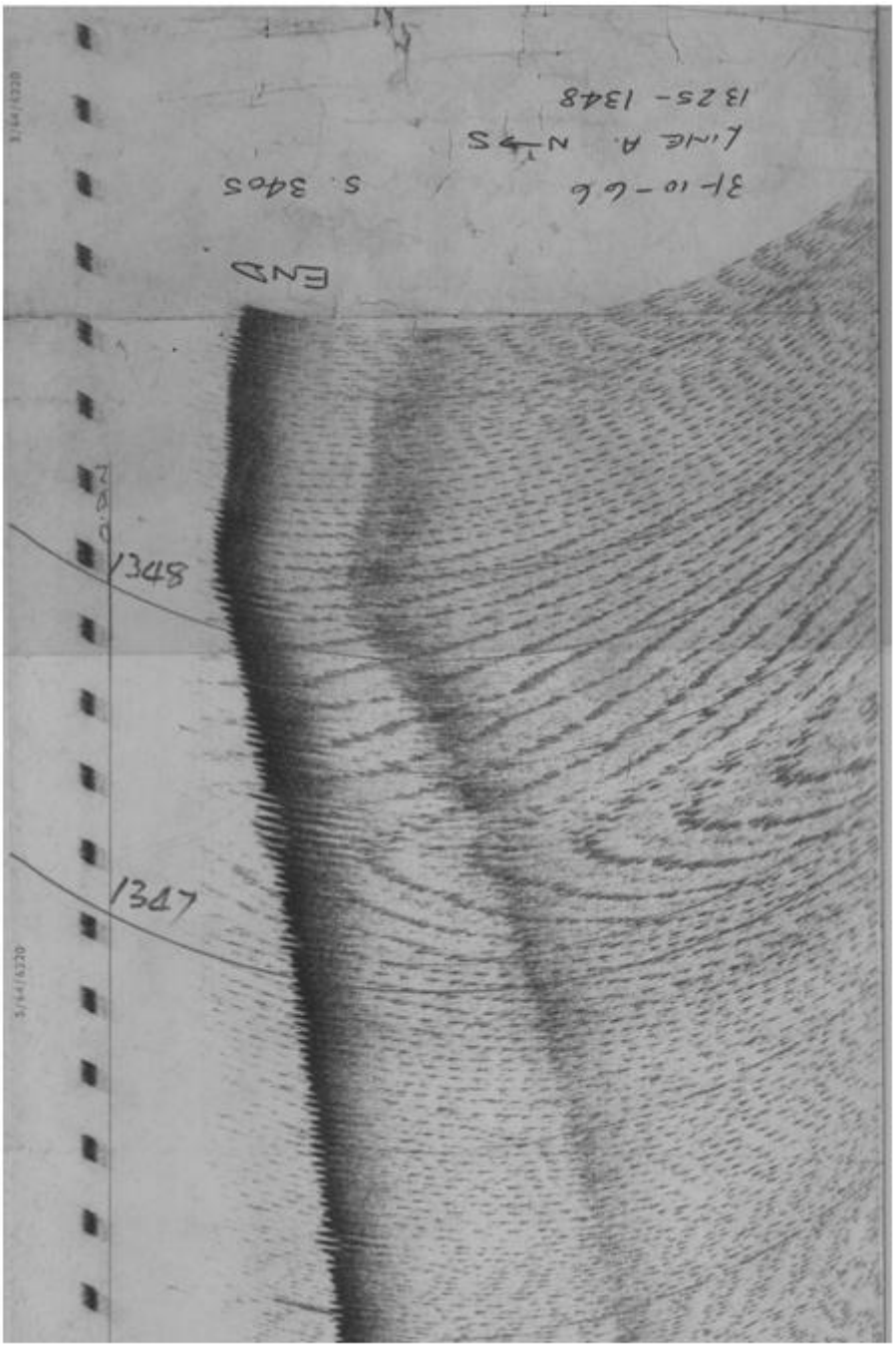


Figure 13 Echo sounder record on carbon type paper media

ECHO SOUNDER RECORDS – GRAPH TYPE PAPER MEDIA

These records are generally of good quality. The scan should be done on Greyscale 300 dpi. These are prone to drifting during scanning as they are folded records.

- **Not SEG-Y Compatible**

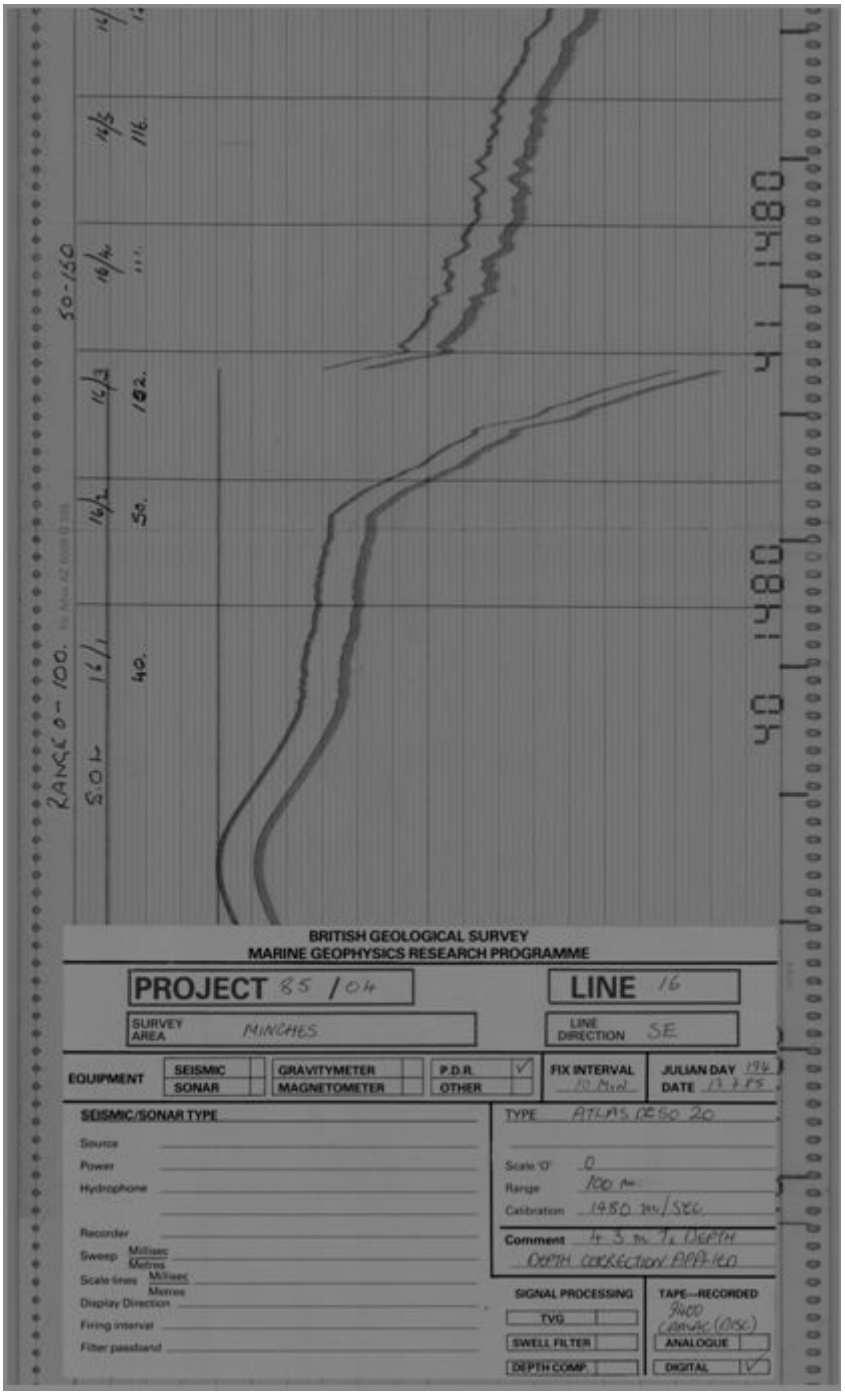


Figure 14 Echo sounder record on graph type paper media

SIDESCAN SONAR RECORDS – WHITE ROLLED PAPER MEDIA

These records are generally of good quality. The scan should be done on Greyscale 300 dpi. These are prone to drifting during scanning as they are generally long records.

- **Not SEG-Y Compatible**

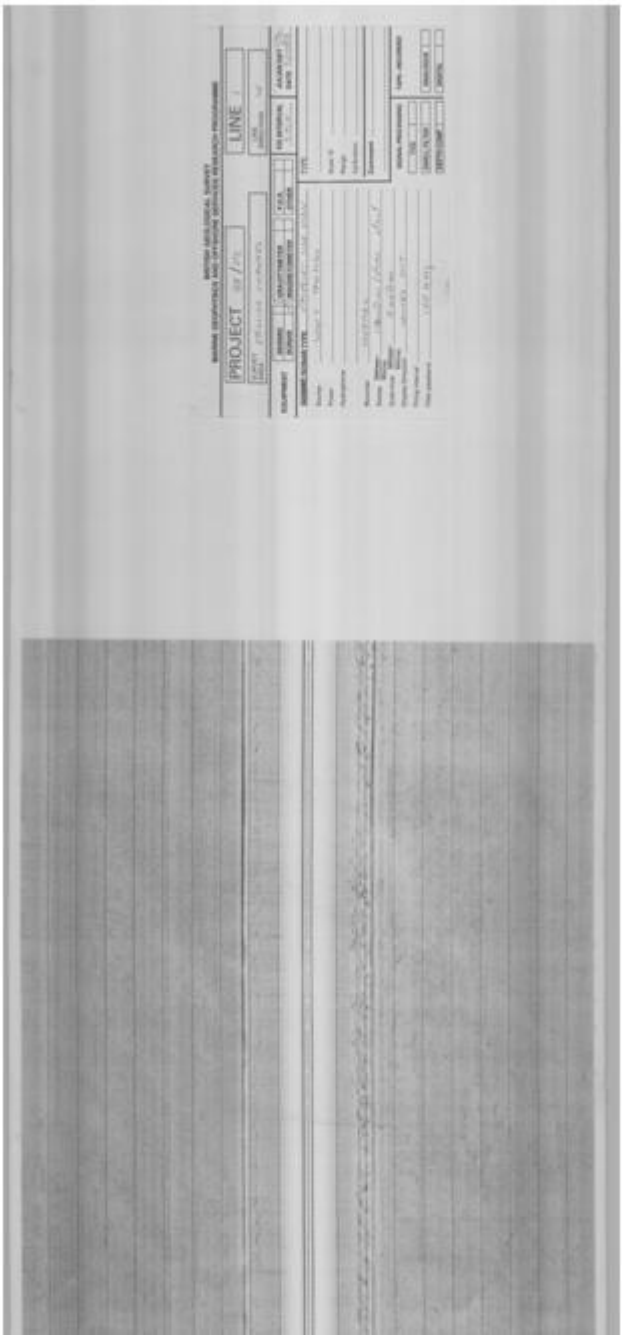


Figure 15 Sidescan sonar record on white rolled paper media

SIDESCAN SONAR RECORDS – TISSUE PAPER MEDIA

These records are generally yellow and brown instead of black and white and are also faded. Therefore the scan should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

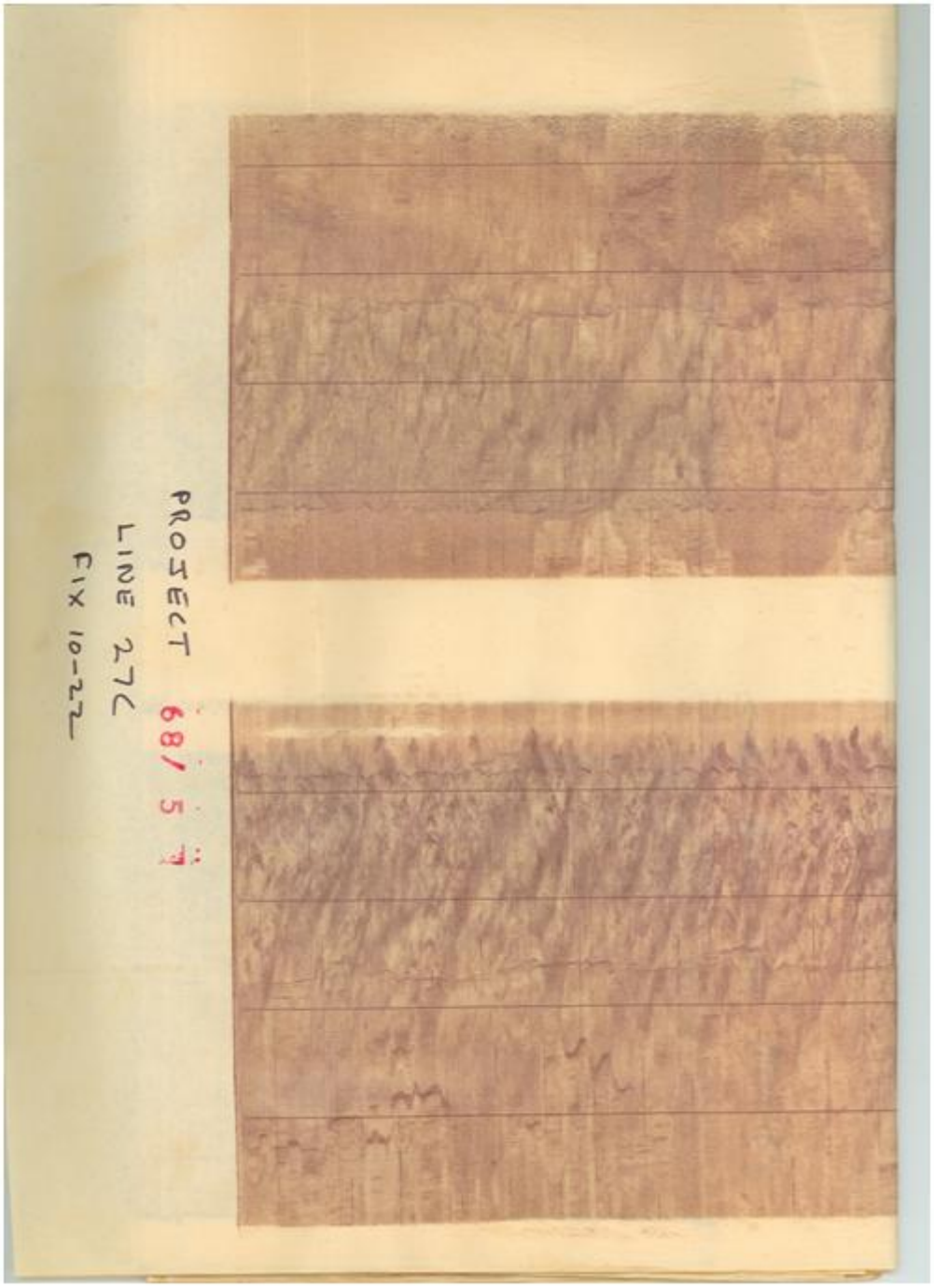


Figure 16 Sidescan sonar record on tissue paper media

TRANSIT SONAR RECORDS – TISSUE PAPER MEDIA

These records are generally too dark to capture anything when scanning so are not useful records. The scan should be done on Greyscale 300 dpi.

These are prone to drifting and twisting during scanning and therefore require constant monitoring during the scanning process.

- **Not SEG-Y Compatible**

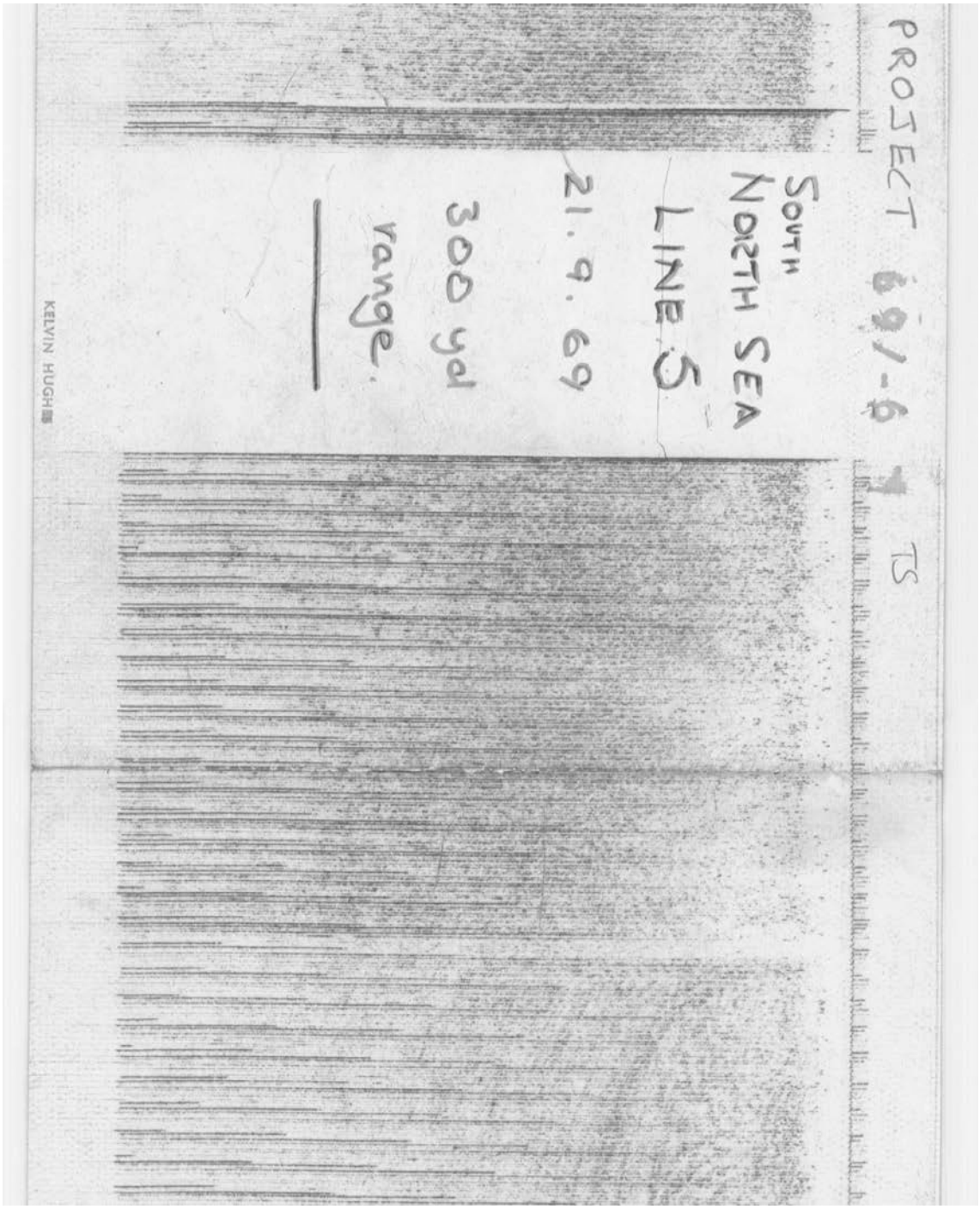


Figure 17 Transit sonar record on tissue paper media

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

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