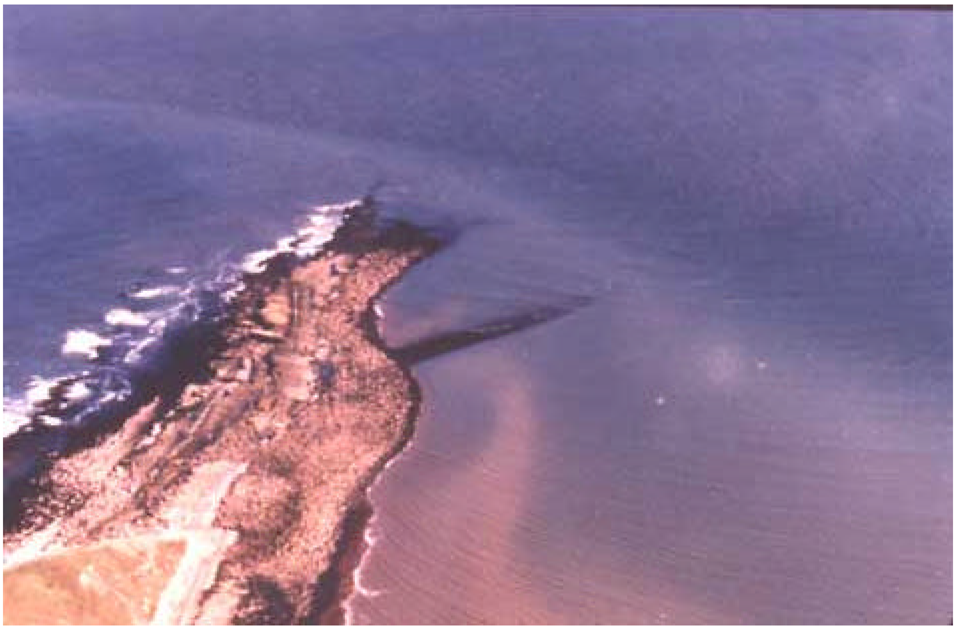
The
Spittals Rock Survey



The Spittals Rock Survey

1997

Report by

Chris Clark and Chris Robinson

Survey carried out by members of
The Filey Brigg Research Group

EXECUTIVE SUMMARY OF THE SPITTALS ROCK SURVEY

Introduction

Controversy has raged for many years over the origin of the sublittoral structure known as Spittals, on the south side of Filey Brigg. Scholars are divided between those that believe that it is a natural formation and those that are convinced it is man made. A group of volunteers, already engaged in underwater biological survey work around the Brigg, undertook the task of trying to settle the matter. They first sought advice from the Nautical Archaeology Society and received instruction in techniques used in underwater archaeology, obtaining the NAS part ll qualification.

The possible origins for the structure were listed:

Natural

- Glacial moraine
- Tidal accumulation of boulders
- Boulders washed from north of the Brigg in extreme weather
- Original coastline before erosion
- of glacial till

Man made

- Natural formation built upon to create pier
- Roman harbour
- Medieval harbour or pier

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During the summer of 1997 a pre disturbance survey of the site was conducted. A datum line was established at the landward sand/rock interface, along the length of the structure. The line was marked at twenty metre intervals with numbered datum markers. A second baseline was established on the Brigg itself. The angle of the structure was measured from various positions and it was found in general it rose from the seabed at an angle of approximately 30 degrees.

Photographic Survey

Due to poor underwater visibility on the site it has been impossible to photograph the structure from sufficient distance to get a general view of the structure, however an extensive photographic rock survey along the whole length of it has given some very useful information. Using the datum marks, sets of photographs were taken of transit lines drawn directly up the structure. Each of these featured a measuring rod which enabled later analysis of the rock sizes. The result of which demonstrates that the structure is very uniform along its entire length and the rock size shows no marked difference at any particular height. The average rock size falls within the range 400-500 mm.

Geological Survey

Discovering the geological origin of the Spittal Rocks was a crucial part of the survey. Using the datum marks in the same way as for the photographic survey, stone samples were collected along each transit line. The samples were taken at random and consisted of a mixture of small pebbles and shards chiseled off the larger boulders. Identification of the samples was carried out by a local professional geologist. It was found that 83% of all rocks sampled were of local origin, the remaining 17% consisted of glacial erratics. The glacial erratics occurred within the pebble samples, whilst virtually all the shards were of local stone.

Sonar Survey

A specially equipped survey vessel conducted a sonar survey, using both side-scan sonar and a fixed depth sounding sonar. The resultant data was professionally processed into accurate charts. The chart reveals a second smaller structure to the east of Spittals.

Conclusion

Examination of the chart propounds the shape of a harbour. Its position is in keeping with other harbours along this coast giving protection from excesses of weather and tide predictable in this part of the North Sea. The geological survey rules out the possibility that the structure is a glacial moraine. The photographic evidence shows uniformity of rock size and no rocks sampled were larger than could be handled by men. Due to the protection afforded by Filey Bay, the likelihood of it being a tidal collection of boulders is negligible and the rock size sampling ruled out the theory that the boulders were washed over the Brigg and channeled into a line by the shape of the Brigg. If it were the remains of the ancient coastline before erosion of the clay, it too would have been eroded and would not remain the massive formation that it undoubtedly is.

The next stage of the survey is to do some limited excavation. To remove some of the boulders to try to find evidence of the wooden supports that were probably used to support the rock infill. Also sifting through the silt in the area known as Crab Hole could reveal artifacts that can be accurately dated.

ACKNOWLEDGEMENTS

The project would not have been possible without the sponsorship of Rural Action for the Environment .

We are indebted to our underwater archaeology experts, John Buglass and Peter Pritchard for their invaluable training and advice throughout this project. We are also indebted to geologist Alan Staniforth for examining and classifying the rock samples, we benefited from useful discussions with him on rock formations of the area. Sincere thanks also to Nick and Dave Johnston, proprietors of British Skysports Parachute Centre, Grindale, who flew over Filey Brigg at low altitude and took some excellent aerial photographs for us. Thanks also to Pip Farline who used his coble *Eglantine* to deploy the baseline along the edge of the Spittals structure; and Bob Missen from Scarborough Borough Council, who smoothed the way for us with the harbour authority and provided some parking passes. Finally thanks to all the team members and friends, listed below in alphabetical order, who helped in various ways to the success of this part of the project.

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Charlie Nolan
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Don Slater
Paul Thompson
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Shona Turnbull

Photographs

Front page, 'An aerial view of Filey Brigg at low water, showing part of the Spittal Rocks', by Nick Johnston
Appendix 2, 'Underwater photographs of a datum marker and a rock size sample', by Chris Clark
Appendix 4, 'Strata on Filey Brigg', by Chris Robinson

FILEY BRIGG RESEARCH GROUP

THE SPITTALS PROJECT

FIRST INTERIM REPORT, SEPTEMBER 1997

INTRODUCTION

The Filey Brigg Research Group was formed in 1997 from members of the local branch of the Marine Conservation Society and other local divers. Its specific intent was to undertake studies in local underwater archaeology. The group successfully completed a course in basic underwater archaeology, run by the Nautical Archaeology Society in April 1997.

Armed with the basic techniques and knowledge and having contracted a professional underwater archaeologist and a professional diver and photographer to oversee the work, the group selected as its first project to investigate a formation on the south side of Filey Brigg known as the Spittal Rocks.

This formation consists of a low lying, reef-like structure, made of rounded boulders of various sizes, which juts out from the southern side of Filey Brigg and runs for over 500 metres, at a maximum height of 8 metres, in a south easterly direction. Spittal Rocks is bared out by only the lowest tides, in fact a tide of at least 6.00 metres is needed to show it at all.

Spittal Rocks is an unusual formation with much local myth and folk memory attached to it, most of which centres round the idea that at sometime in the past it had been used as a pier or mole for the loading/unloading of ships. Some local legend has it to be of Roman origin. Shaw writing over a hundred years ago about his walks along the coast, describes how it stretched across Filey Bay; he refers to it as "the remains of a breakwater, built by the Romans".[1] With documentary evidence of this being fragmentary and unreliable, it was felt that the only course possible was a full on-site investigation to determine the true nature of Spittals.

POSSIBLE ORIGINS FOR SPITTAL ROCKS

After prolonged discussion within the group and consulation with the archaeologists it was agreed that there were three main possible origins for this formation:

1 That the structure was entirely natural and was formed by the processes of erosion and deposition common to coastlines, or that this feature was of a fossil nature dating back to the last ice age, possibly a glacial moraine.

2 That the feature we see today was natural in origins but had sometime in the past been built up or improved in order to provide a useful pier which had since fallen into disrepair.

3 That the structure was wholly man made and had been a harbour installation in the past, possibly of Roman or Medieval origin.

INVESTIGATION STRATEGY FOR FIRST SEASON'S WORK

To the general public at large any form of archaeology consists of digging holes and retrieving artifacts to display in museums. What is probably not recognized is that before any site can be excavated it has to be fully surveyed and mapped. This is essential as excavation archaeology is a one way destructive process, once excavated a site cannot be fully restored. Therefore it was decided after consultation, to restrict the first season of field work to the completion of a pre-disturbance site survey.

INITIAL SURVEY STRATEGY

It was felt by the group that the first season's objectives should not be overly ambitious and must consist of targets that were reasonably achievable within the short diving season that is usual on this coast. It was decided to attempt the following objectives in the first season.

1. To survey the structure and produce a plan of the site, showing its size, structure and form.
2. To complete a full photographic survey of the site in order to compare the sizes of the boulders that form the Spittals and determine how uniform it is.
3. To take a set of stone samples along transit lines every 20 metres, down the side of the Spittals and by identifying them, determine the geological origins of the structure.
4. To make an underwater video of the Spittals which could be used for public information and a public relations tool for fund raising.

ESSENTIAL WORK CARRIED OUT PRIOR TO SURVEY

In order to carry out any survey work on land or sea it is essential to have a series of fixed points joined together to form a baseline or datum, from which objects can be measured or referenced. Working on a site like Spittals, where visibility is often less than 0.5 metres, a fixed baseline is even more vital, to prevent divers becoming disorientated and lost.

The baseline used on this site consisted of a 12 mm polypropylene rope, 440 metres long with a concrete distance marker/sinker every 20 metres. The position of each sinker was marked with white surface marker buoys - the 0, 100 m, 200 m, 300 m, and 400 m buoys being red in colour. Where the baseline was to be deployed needed careful consideration. The top of the formation is broad and flat and it gradually slopes down to Crab Hole *(figure 2 - Filey Brigg, showing local site names)* on the seaward side. This boundary was too indistinct and open to interpretation to be reliably used. The landward side, however, is ideal as the boulders that make up Spittals slope down at a fairly constant 30 degrees until they merge with the sand. It was decided to deploy the baseline along the rock/sand interface for its full length of 440 metres.

This had two main advantages:

> Firstly the whole baseline together with the buoys could be laid from a boat using sonar, by keeping the rock/sand interface in the centre of the sonar display. Full deployment of the baseline took 50 minutes to complete and on being checked by divers was surprisingly accurate.
>
> Secondly, it made underwater navigation easier - if a diver found himself on rock then he was on Spittals, if on sand then he was off it. If on sand and lost, all that was required was to swim along a compass course of NNE or approximately 35 degrees magnetic in order to find the baseline again.

A further advantage of working from the baseline up the slope was that divers were somewhat sheltered from the effects of the tide.

(*See Appendix 1* Base Line Deployment)

INITIAL SURVEY STRATEGY AND TECHNIQUES

Having established a fixed datum line from which to work on the Spittals, it became necessary to establish another baseline on the Brigg itself. This took the form of three fixed survey points placed high up on large flat rocks (the criteria for these was that they had to be level, stable, unlikely to move and be big enough to accommodate a surveyor and an electronic ranging theodolite or E.R.T.). The three points chosen were; one directly opposite the base of Spittals and the other two approximately 70 metres east and west of it. *(refer to diagram - figure 2)* Each point was marked by drilling the rock and inserting 12 mm Rawl bolts. To further aid identification, each rock was sprayed with yellow surveyor's marker paint.

The intention was to employ a surveyor to accurately plot and range the survey points relative to each other and the position of the marker buoys relative to the survey points by ranging and triangulation. By doing this a good map of the outline of Spittals could be obtained.

Location of Filey Brigg and Spittal Rocks

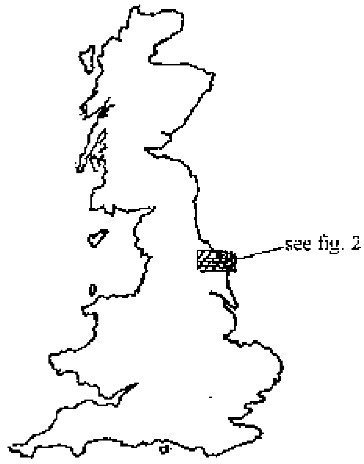
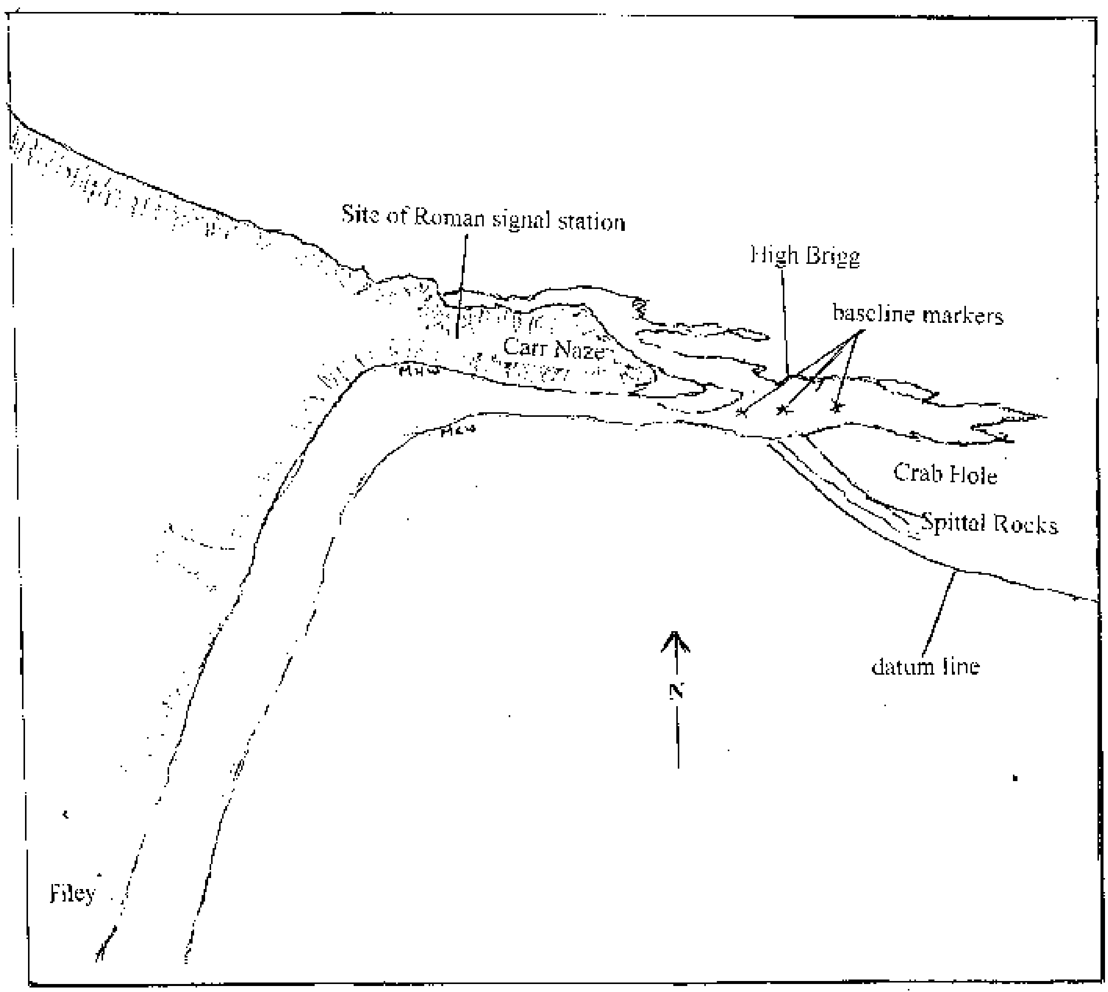


Figure 1 - location of Filey

Figure 2 - Filey Brigg



Before the work proceeded any further, fate conspired to lend a hand from a most unexpected and welcome source. Some three weeks after the baseline was deployed a 20 metre survey boat arrived in Filey Bay. The boat was contacted to inquire whether they had surveyed the area around Spittals, only to be told that they couldn't get into that area because of the large number of surface marker buoys. A deal was struck between the group and the surveyors whereby the marker buoys were removed in exchange for copies of the survey data obtained around Spittals. This data proved to be of a very high quality consisting of sonar and side-scan sonar, all of which was linked to survey points from the G.P.S (Global Positioning System). The acquisition of this data has saved the group a considerable amount of time and work. The data has been processed into charts of the area which are far more detailed and accurate than any the group could hope to achieve by conventional means. *(see bathymetric chart - page 15a)*

PHOTOGRAPHIC SURVEY OF ROCK STRUCTURE

Introduction

To determine whether the structure of Spittals is a natural or man made formation, various specialists were consulted. During discussion with a geomorphologist it became apparent it was important to establish the size of rocks at different locations on the structure. An attempt was made to measure and record rock size by divers, using tape measures and underwater recording sheets. Difficulty in establishing position and in communication in the very low visibility usually encountered on Spittals made this method unworkable. The size of the site and the difficult working conditions determined the method finally employed.

Equipment

A Motor Marine 11 camera with YS50 TTL strobe was used. Due to bad visibility it was decided to use the 20 mm wide angle lens with a focusing range from 0.4 metres to infinity. The camera focus was set to infinity and aperture to f/11. The strobe was used with the Through The Lens function. Film type was standard 35 mm cartridge, film speed ISO 100. The measuring rod was one metre long, marked throughout its length in alternate black and white sections, each 100 mm long.

Method

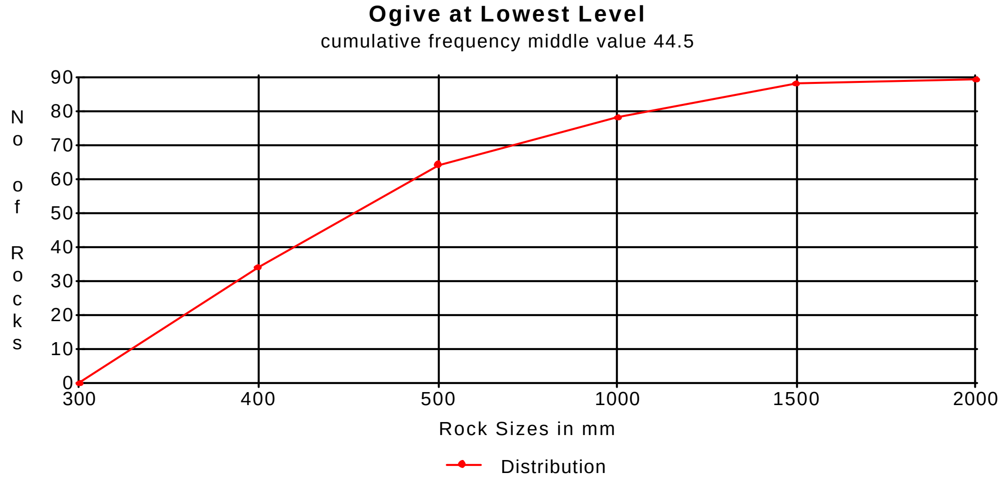
The datum line, which was laid along the bottom of the structure at the beginning of the survey, consists of numbered markers twenty metres apart, connected by rope for easy location in poor visibility. *(see appendix 1)* From each of the numbered datum markers a transit line was marked directly up the face of the structure, using a compass to establish position. Photographs were taken, first of the numbered datum mark and then of a measuring rod which was laid on the rocks at one metre intervals, starting at the lowest point and ending in the kelp line at the top of the structure. *(see appendix 2)* For each new transit the datum marker was photographed before the first point so that no written recording was needed underwater, the position on the film determined the location of the photographs. Once the method was established and proved workable, several transits could be covered in a single dive, the only constraint being the length of the film. Even in poor visibility the results were usable.

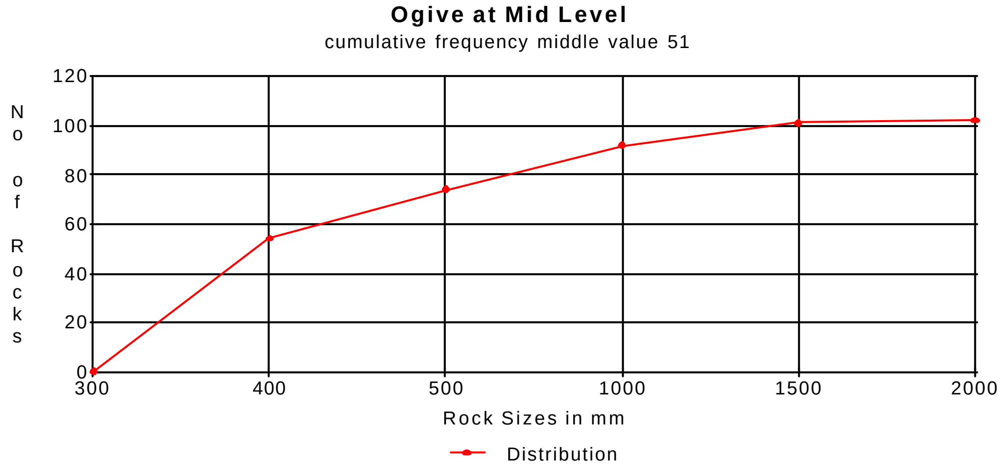
The orientation of each photograph can be ascertained by the direction of flash, the light comes from the left of the photograph and each picture is taken in 'landscape' form. Each photograph is numbered on the back to establish its location on the structure, first with the number of the datum marker, followed by the number of the transit point, e.g. 120.3 was the third photograph taken from datum point 120, approximately three metres up the structure. As the focal distance varies slightly from frame to frame, a template of the measuring rod was made in each frame to accurately measure all the rock sizes in that frame. Originally the size range selected measured rocks from less than 100 mm to over 1.5 m. These were recorded on a spreadsheet, i.e. all the rocks were graded on every photograph and the numbers for each size range noted. Due to the inaccuracy that this method produces in practice, some modification was introduced later. For instance, when a rock of up to 1.5 m is photographed from less than 1 metre focal distance, only that rock will appear on the photograph, whereas an area of rocks measuring between 100 mm and 200 mm, photographed from the same focal distance will have a high tally. This will produce deviation from what we would expect to find in the area photographed. To counteract this anomaly we referred to the geological samples and found that many of the smaller rocks were of glacial origin, probably from the decay of the local glacial till cliffs which contain mainly boulders of this type and size. As these rocks could have been deposited on the site by various means, either as infill or by natural processes, through erosion or quarrying activity, it was decided to exclude them from the size range. None of the rocks measuring less than 200 mm were included in working out the average rock size to be found throughout the structure. *(spreadsheet results are printed as appendix 3)*

Results

As the frequency distribution includes open ended classes it was decided to use the median method of averaging as this would give a fairer evaluation than the arithmetic mean. The cumulative frequency was calculated for the rock sizes at the lowest level, mid level and highest level, all along the structure and also for the entire photographed range. The lowest level was at the sea bed but the middle and the top of the structure varied in height from the sea bed as overall height varied from three metres to eight metres. Using the cumulative frequency middle value on each ogive, the median is obtained.

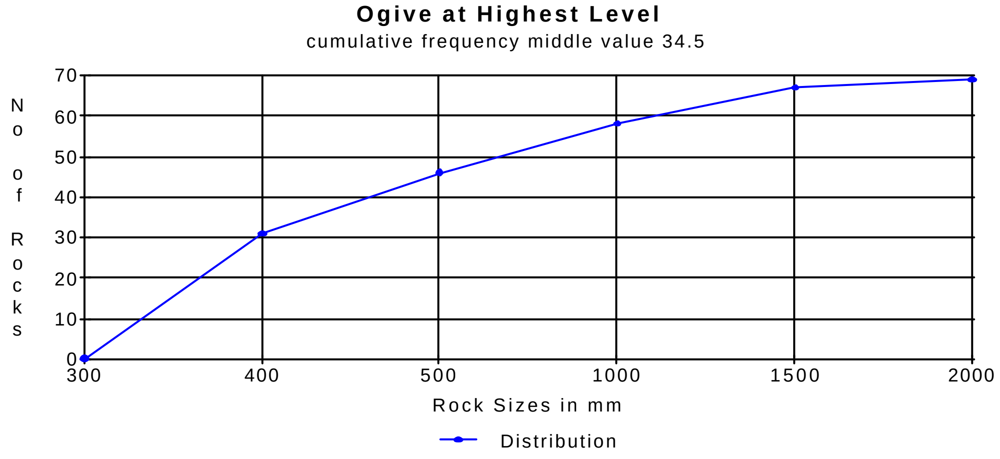
Graphs 1 & 2:-





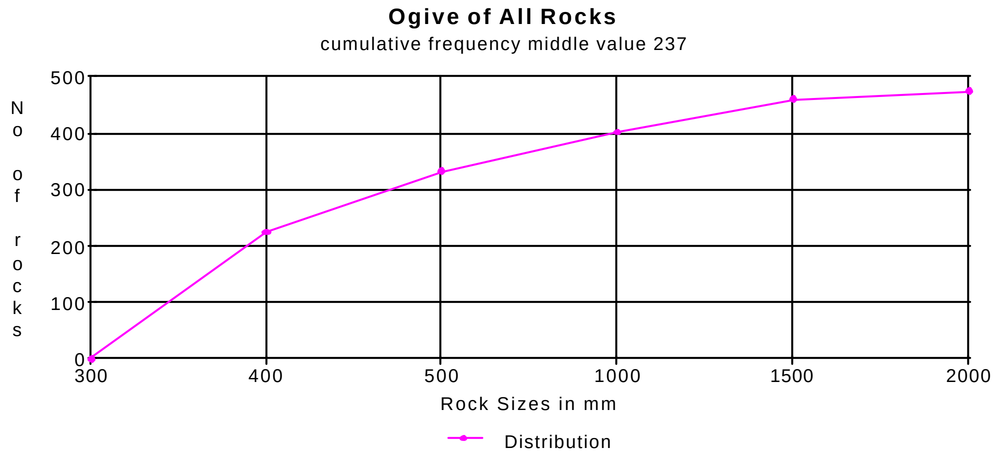
The median for the highest level and the lowest level of the entire structure were very close, around 420 - 430 mm, *(graphs 1 & 3)* whereas at the mid level it was a fraction under the 400 mm mark. *(graph 2)*

Graph 3



Using all the photographic data an overall median of around 410 mm was calculated. *(graph 4)* Which corresponds with the general impression when swimming over the area that the average rock size is between 400 - 500 mm.

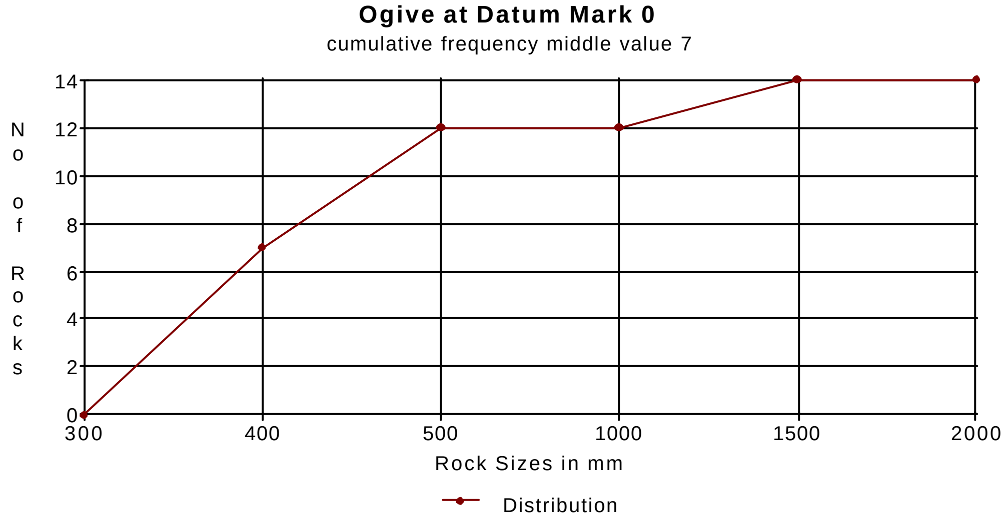
Graph 4



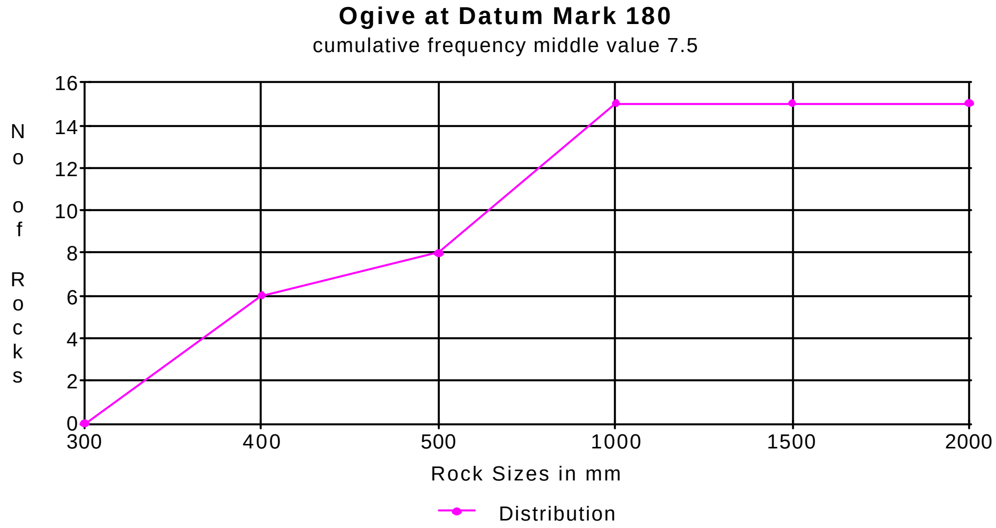
In addition, cumulative frequency ogives were done for the transits from datum marks 0, 180 and 380. These all produced an average rock size of between 400 mm to 500 mm.

Further analysis of the ogives showed that at datum mark 0, *(graph 5)* the median rock size was just above 400 mm, at datum mark 180, *(graph 6)* the median was about 475 mm and at datum mark 380, the median was 500 mm. *(graph 7)*

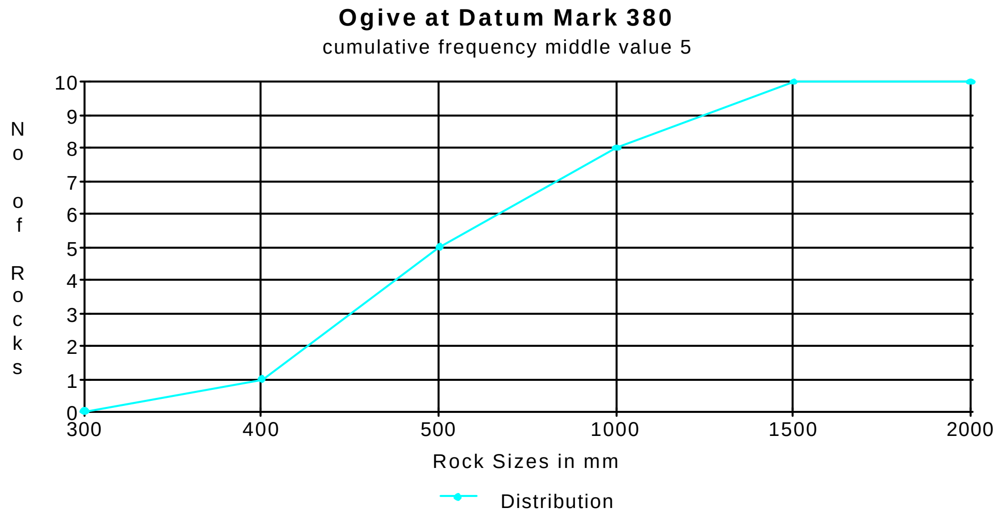
Graph 5



Graph 6



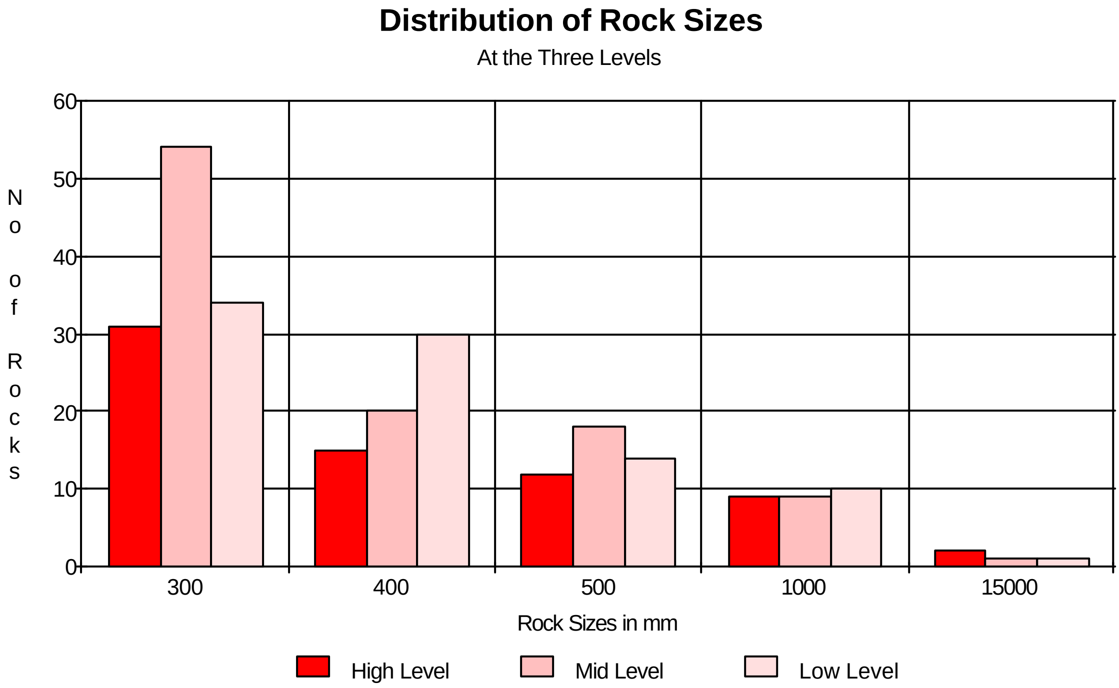
Graph 7



Conclusion from Photographic Survey

Throughout the length of the structure there is no marked difference in the composition of rock size. A bar chart was drawn to show the distribution of rock sizes at the three levels. *(graph 8)*

Graph 8



If the structure is man made and in its original state we would expect to find the largest rocks at the lowest levels and smaller ones at the top. This did not occur, therefore we conclude that if the structure is man made, it is probable that the structure has collapsed due to natural processes, either tidal movement and heavy seas or colonisation by destructive animals. Most of the rock samples collected were honeycombed with the burrows of Wrinkled Rock Borers, *Hiatella arctica*[2,] which are a rock boring bivalve commonly found in the limestone and other calcareous rocks in the locality. An alternative theory of construction has been suggested in the past, that a non selective use of the materials was made, namely that the rocks were dropped from barges.

Analysis of the transits 0, 180 and 380 disprove the theory put forward that rocks could have been washed over the Brigg in extreme weather conditions and channelled into a line by the shape and structure of the Brigg. If this had occurred then it would be expected to find that the larger rocks would be nearer to the Brigg (datum mark 0) and the smaller ones at datum mark 380. As can be seen from the ogives the opposite is true.

The conclusion for the photographic survey is that the rocks are of a size well within the capabilities of men, using simple tools and methods, to move and place them on the structure. No rocks larger than 1.5 m were encountered along the photographed transits.

GEOLOGICAL SURVEY OF ROCKS FORMING STRUCTURE

Introduction

During initial project planning it was realised that the geological origins of the Spittal Rocks was crucial in deciding the question of what the structure was and how it came to be there. For instance, if the structure was of glacial origin then it would largely consist of glacial erratics, if on the other hand, the structure was of local stone then this would suggest a man made construction.

Method

After much thought the following sampling regime was devised. Ten rock samples should be taken along each of the transit lines (as used in the photographic survey) at each of the base line stations, i.e. at 20 metre intervals. These samples to be taken at random and consist of an even mixture of pebbles - stones small enough to fit in the hand - and shards - pieces of stone chiseled off the larger boulders. Identification of samples to be carried out by a professional geologist with local knowledge.

A total of 210 samples were taken over a period of about eight weeks, each batch taking an hour to collect. The batches of samples represent 20 individual dives, a considerable amount of work. Identification was carried out without any problems.

Results and Analysis

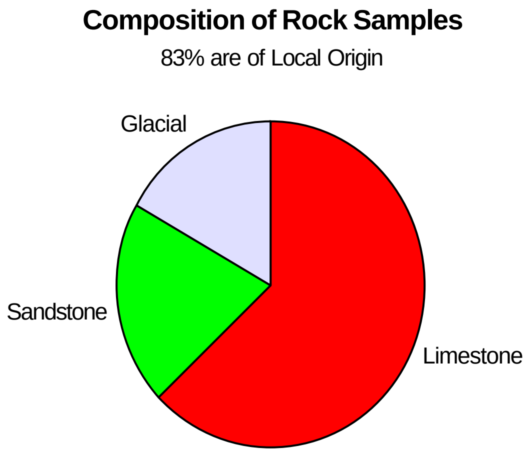
Table: Geological Analysis

Stone type	Pebbles	Shards	Total
Oolitic Limestone	5.7%	57%	62.7%
Oolitic Sandstone	2.3%	18%	20.3%
Basalt	4.7%	0.95%	5.65%
Ironstone	0.47%		0.47%
Lava	0.9%		0.9%
Quartz	1.4%		1.4%
Limestone Erratics	3.3%		3.3%
Sandstone Erratics	5.3%		5.3%

Result

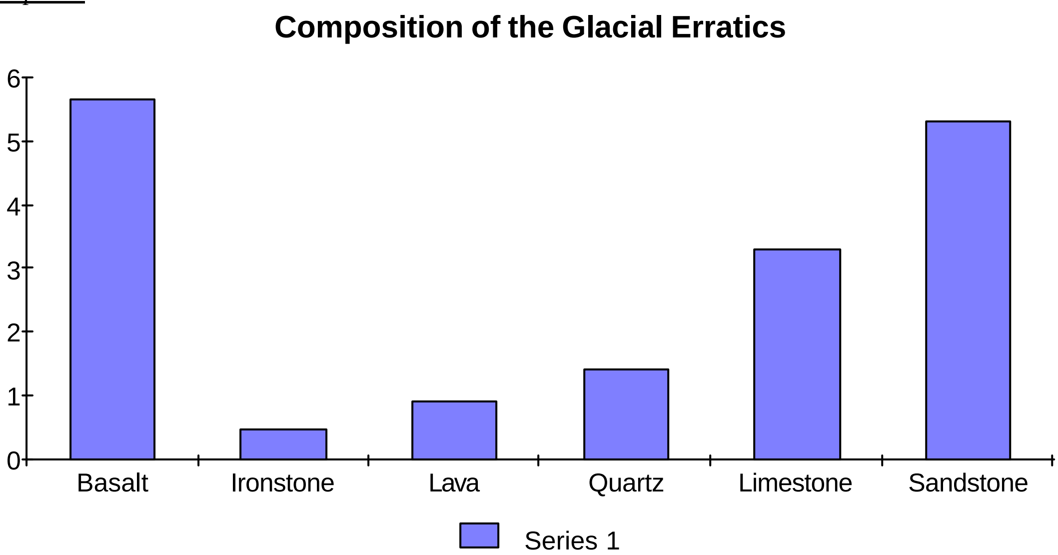
83% of all rocks sampled are of local origin
62.7% of which are limestone
20.3% of sandstone. *(see graph 9)*

Graph 9



The remainder of the samples - 17% of the total - consist of glacial erratics. It is interesting to note that all the glacial erratics occur within the pebble samples, whilst the shards taken from the larger rocks are virtually all local stone. *(graph 11)*

Graph 10

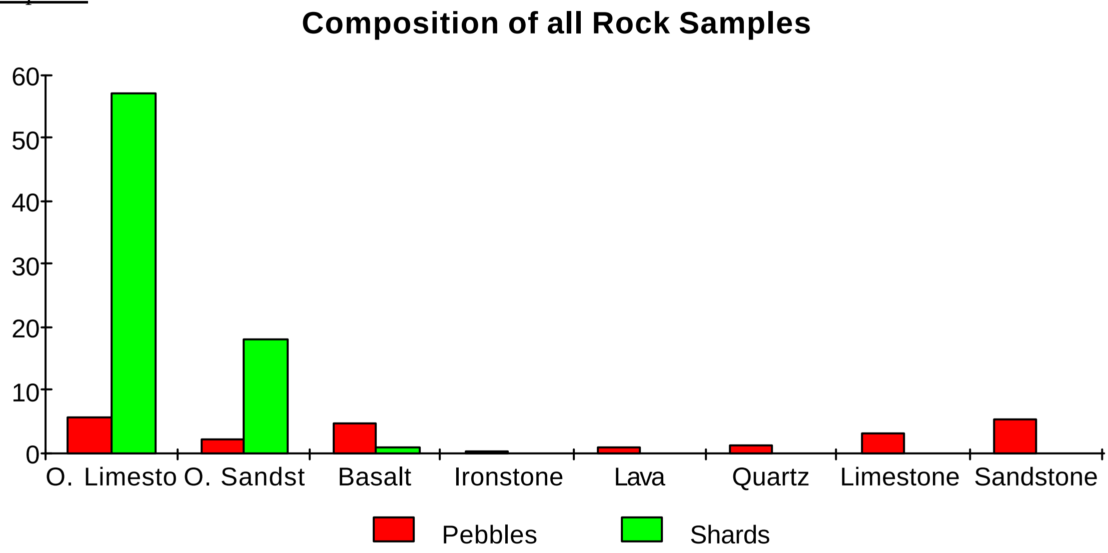


Conclusion from Geological Analysis

The source of the glacial erratics is undoubtedly the local cliffs which consist of a thick layer of glacial boulder clay, containing about 10% stones and sand, lying above the layers of limestone and sandstone rocks. These stones are consistantly being deposited on the beach as a result of cliff erosion.

From these results it is easily seen that the Spittals are not of glacial origin.

Graph 11



A further point made by the geologist was that if the Spittal Rocks were a glacial moraine, the chances of a structure of that size surviving erosion for 13,000 years, since the last ice age, are negligible.

As a consequence of discovering that Spittals is composed of local rock, it was decided to compare the samples with stone strata on Filey Brigg. The result of the comparison is that the samples taken from Spittals match the topmost layers of stone on the Brigg. *(see appendix 4 - Filey Brigg)*

SONAR SURVEY

Method

The survey was conducted by a 20 metre survey vessel specifically equipped for the task.
The vessel used two sonar systems, one being a fixed depth sounding sonar, operating on a through hull transducer; the other was a towed array side-scan sonar. Both systems were tied into and coordinated with the Global Positioning System (G.P.S.) via two receivers. Definition and recording were highly accurate.

Initial Survey

The vessel carried out three runs across the survey area in order to establish size and shape of target to be charted and maximum and minimum depths. Results were analysed and found to be in need of recalibration, as the area covered went too far to the west and did not include enough of the southern aspect; this was accomplished by liaison between surveyor and research group.

Main Survey

The main survey was carried out on a planned survey grid of ten parallel runs across the target area. Ample overlap was left to cover any additional unexpected features around the main target. Target overlap was in excess of 500% by side-scan, as each run was approximately 60 metre in width. The runs were running parallel with the Brigg's southern shore.

Results

The side-scan results were slightly disappointing, as apart from showing the main structure of Spittals, no more specific details could be resolved. These results were largely due to the shallowness of the site and the confused nature of the seabed, which consists of sand, mud, gravel, broken shells and small boulders. However, the depth sounding sonar results were excellent. Once processed into digital information they were used to make the bathymetric chart included in this report. The raw data is stored in Filey and can be examined on request.

The chart is of a standard format, all points of equal depth being linked to form contour lines, the distance between them being 1 metre. The chart clearly shows the full extent of the Spittals, which runs for a distance of at least 520 metres from the Brigg**.** To the east is another smaller structure, similar to Spittals, it runs southerly from the end of the Brigg for 130 metres.

SIZE OF SPITTAL ROCKS

From the bathymetric chart it can be seen that this formation runs for a total of 520 metres from the landward end to the 9 metre contour. Given that the above chart is so accurate it was felt reasonable to calculate the volume of the formation directly from the chart. First a centre line was drawn down the formation by bisecting the contour lines (see chart). Then the assumption was made that the seaward side half sections buried under mud and sand would be a 'mirror image' of the landward side. Six sections were taken at 100 metre intervals with the following results:-

1) 92 m^2 2) 96 m^2 3) 198 m^2 4) 294 m^2 5) 100 m^2 6) 84 m^2

These sections simply averaged = $\frac{\text{sum areas}}{6} = \frac{864\ m^2}{6} = 144\ m^2$ x length of structure = 520 m, therefore, = volume of 74,880 m^3 or approximately 75,000 m^3 of stone.

Note

Taking density of limestone/sandstone as approximately 2.240 tonnes/m^3, we can therefore calculate mass as follows: mass = volume x density, therefore mass of Spittals = 2.240 x 75,000 = 168,000 tons

If this formation is man made, the amount of labour involved can be estimated, (assuming using hand tools and carts only) as follows:

1 man day per m^3 to quarry the stone + 1 man day per m^3 to transport the stone. The labour can be estimated at 150,000 man days or $\frac{150,000}{365 \text{ (day per year)}}$ = 1 year's work for 410 men

CONCLUSION FROM PRE-DISTURBANCE SURVEY

If the premise, that the structures charted by the sonar survey are artificial, is true, then together they suggest the two enclosing arms of a harbour. The actual harbour basin would have been the area now known as Crab Hole. This basin measures 4,500 square metres, or just over one acre. Not massive by today's standards but quite adequate for the size of ships common in antiquity.

Having examined all the evidence in detail, it is difficult to visualise what natural processes could give rise to a structure with such steep sides and homogeneous construction. It is totally different from any other part of the Brigg, or other local coastal features. The exceptions being the known medieval piers at Flamborough, South Landing and Bridlington[3] which bear a resemblance to the Spittals. These piers were constructed of a stone core around timber piles flanked with timber planks and a top decking. This method of construction being very common in Europe until the 1,900s, when machine working of stone and widespread use of concrete became the norm.

A geologist is reported to have declared the Spittal Rocks to be a "cranch", explained as a tidal accumulation of boulders[4]. However, as Professor Gilligan was quoted in 1935, one can assume that he did not personally inspect the whole structure underwater. Today he would find it hard to explain what combination of tides and weather could have deposited the structure in its present form, bearing in mind that it lies sheltered from the worst of the weather and tides. Its aspect is in line with all the major harbours along this coast, i.e. the opening facing south east.

The only way to prove the hypothesis that the structure is a man made pier or harbour is to date its construction. To do this some artifact must be obtained from within the structure which can be accurately dated.

References

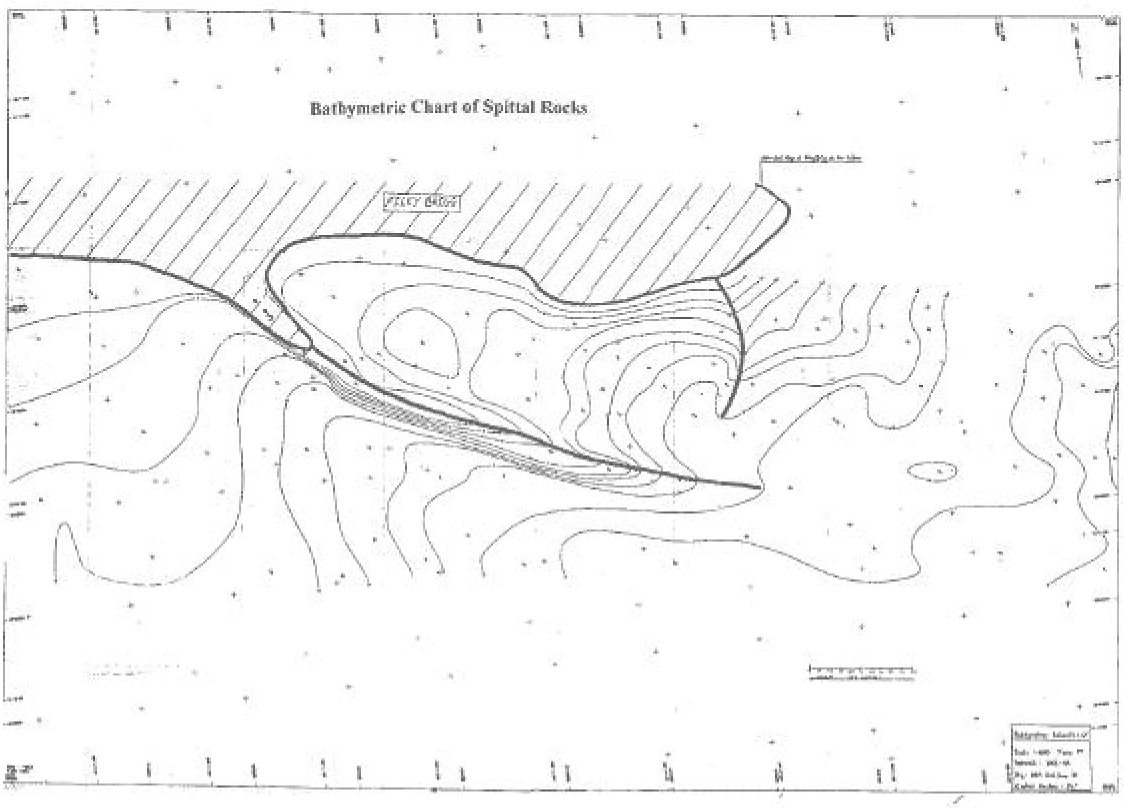
1 Shaw George, Rambles about Filey, London: Hamilton Adams and Co, 1867.

2 Hayward Peter, Neslon-Smith Tony, Sheilds Chris, Sea Shore of Britian & Northern Europe, Collins Pocket Guide, London: HarperCollins, 1996.

3 Johnson Mark, A Medieval Harbour at Flamborough, The Yorkshire Archaeological Journal, Vol. 60, 1988, p105-111.

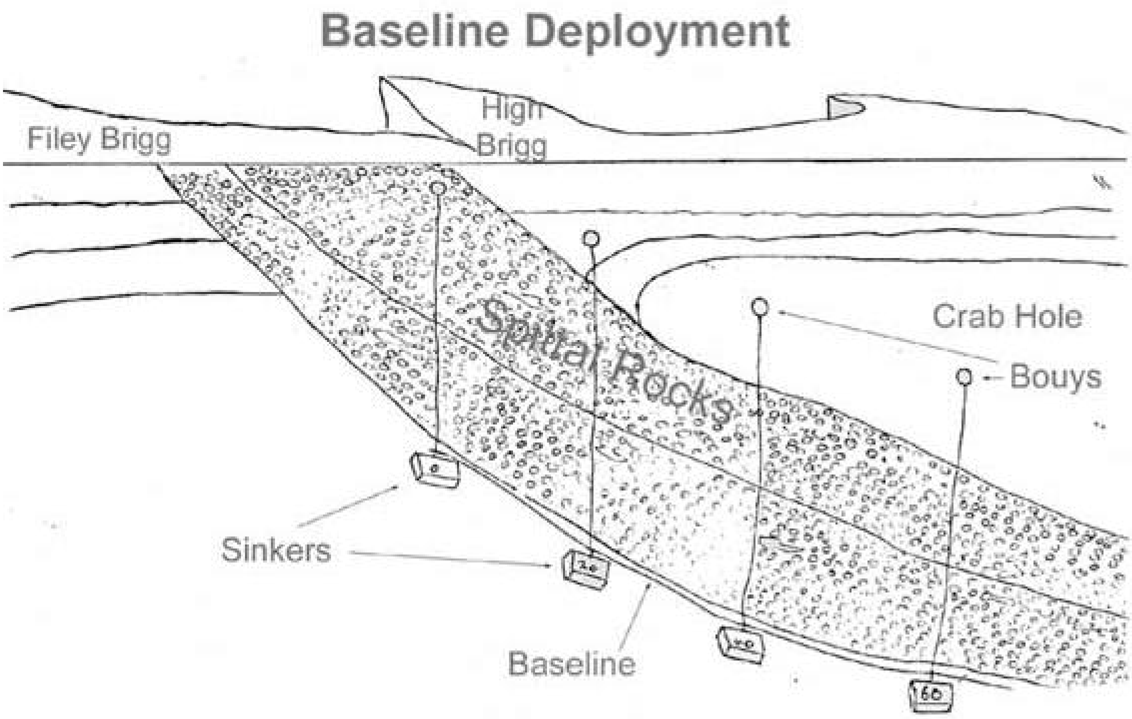
4 Kitson-Clark Mary, A Gazeteer of Roman Remains in East Yorkshire, 1935, p 82

Bathymetric Chart of Spittals Rocks



APPENDICES

Appendix 1 – Baseline Deployment



Appendix 2 - Photograph of a Datum Mark and Rock size sample

Datum marker at base of rock structure

Measuring rod on rocks approximately three metres up structure (10cm gradations)

Appendix 3a

Photographic Survey of Rock Sizes

At the top of each numbered column is the photograph number, e.g. 0.1 is the first photograph from datum mark 0.

Size Range	0.1	0.2	0.3	0.4						Total
0-100mm	0	4	1	0						5
100-200mm	0	3	3	2						8
200-300mm	3	4	0	0						7
300-400mm	1	2	2	0						5
400-500mm	0	0	0	0						0
0.5-1m	1	0	0	1						2
1m-1.5m	0	0	0	0						0
Size Range	20.1	20.2	20.3							Total
0-100mm	0	1	0							1
100-200mm	2	3	2							7
200-300mm	3	0	3							6
300-400mm	3	3	2							8
400-500mm	0	0	1							1
0.5-1m	0	0	0							0
1m-1.5m	0	0	0							0
Size Range	40.1	40.2	40.3							Total
0-100mm	0	0	0							0
100-200mm	2	5	0							7
200-300mm	1	4	2							7
300-400mm	2	0	1							3
400-500mm	0	0	1							1
0.5-1m	1	0	0							1
1m-1.5m	0	0	0							0
Size Range	60.1	60.2	60.3	60.4						Total
0-100mm	1	0	4	3						8
100-200mm	1	0	5	6						12
200-300mm	3	0	3	0						6
300-400mm	1	1	1	3						6
400-500mm	0	2	0	0						2
0.5-1m	0	0	0	0						0
1m-1.5m	0	0	0	0						0
Size Range	80.1	80.2	80.3	80.4	80.5	80.6				Total
0-100mm	0	0	0	2	0	0				2
100-200mm	0	1	2	2	5	3				13
200-300mm	2	2	0	2	4	1				11
300-400mm	0	0	1	1	0	0				2
400-500mm	0	0	1	1	0	0				2
0.5-1m	0	1	1	0	0	0				2
1m-1.5m	0	1	1	0	0	0				2

Appendix 3b

Size Range	100.1	100.2	100.3	100.4	100.5	100.6	100.7	100.8		Total
0-100mm	0	0	0	1	3	2	4	0		10
100-200mm	0	4	1	6	5	9	4	1		30
200-300mm	1	2	2	4	3	1	3	0		16
300-400mm	3	0	1	1	1	0	1	0		7
400-500mm	0	1	0	0	0	0	0	0		1
0.5-1m	0	0	0	0	0	0	0	2		2
1m-1.5m	0	0	0	0	0	0	0	0		0
Size Range	120.1	120.2	120.3	120.4	120.5					Total
0-100mm	0	2	1	0	0					3
100-200mm	0	0	1	0	0					1
200-300mm	0	5	6	0	2					13
300-400mm	0	6	0	0	0					6
400-500mm	0	0	3	0	1					4
0.5-1m	1	0	0	1	1					3
1m-1.5m	0	0	0	1	0					1
Size Range	140.1	140.2	140.3	140.4	140.5					Total
0-100mm	0	0	0	2	13					15
100-200mm	0	5	3	4	5					17
200-300mm	1	3	3	3	2					12
300-400mm	0	1	1	3	4					9
400-500mm	1	0	1	0	0					2
0.5-1m	2	2	0	2	0					6
1m-1.5m	0	0	0	0	0					0
Size Range	160.1	160.2	160.3	160.4	160.5					Total
0-100mm	0	0	0	1	5					6
100-200mm	0	0	0	2	4					6
200-300mm	0	1	1	1	1					4
300-400mm	3	0	0	1	0					4
400-500mm	4	2	1	0	2					9
0.5-1m	0	0	3	2	0					5
1m-1.5m	0	1	0	0	0					1
Size Range	180.1	180.2	180.3	180.4						Total
0-100mm	0	10	10	6						26
100-200mm	8	8	5	5						26
200-300mm	0	1	3	2						6
300-400mm	0	1	0	1						2
400-500mm	6	0	1	0						7
0.5-1m	0	0	0	0						0
1m-1.5m	0	0	0	0						0

Appendix 3c

Size Range	200.1	200.2	200.3	200.4	200.5	200.6	200.7	200.8		Total
0-100mm	0	1	0	1	0	4	0	5		11
100-200mm	0	0	0	3	1	0	0	3		7
200-300mm	0	4	4	5	0	1	0	2		16
300-400mm	2	1	0	1	0	1	0	1		6
400-500mm	0	1	1	0	0	0	0	0		2
0.5-1m	1	1	1	1	3	0	0	1		8
1m-1.5m	0	0	0	0	0	1	1	0		2
Size Range	220.1	220.2	220.3	220	220.4	220.5				Total
0-100mm	0	0	11	0	1	4				16
100-200mm	1	6	1	0	0	2				10
200-300mm	5	4	5	4	1	3				22
300-400mm	4	0	1	2	2	0				9
400-500mm	0	0	0	1	3	0				4
0.5-1m	0	1	0	0	0	2				3
1m-1.5m	0	0	0	0	0	0				0
Size Range	240	240.1	240.2	240.3	240.4	240.5	240.6			Total
0-100mm	0	2	2	0	7	5	16			32
100-200mm	0	4	0	4	0	4	0			12
200-300mm	2	4	1	2	3	2	2			16
300-400mm	0	0	2	1	1	1	2			7
400-500mm	0	1	0	1	0	0	2			4
0.5-1m	2	1	1	1	1	2	0			8
1m-1.5m	0	0	1	0	0	0	0			1
Size Range	260	260.1	260.2	260.3	260.4	260.5	260.6	260.7		Total
0-100mm	0	0	0	17	15	4	10	10		56
100-200mm	0	0	0	2	9	5	3	3		22
200-300mm	0	3	0	0	4	6	1	1		15
300-400mm	4	1	2	0	2	1	0	0		10
400-500mm	1	2	0	0	1	1	0	1		6
0.5-1m	0	0	0	2	1	0	0	1		4
1m-1.5m	1	0	1	0	0	0	1	0		3
1.5m+										
Size Range	280	280.1	280.2	280.3	280.4					Total
0-100mm	0	0	0	5	0					5
100-200mm	0	0	1	4	0					5
200-300mm	0	2	3	3	0					8
300-400mm	0	0	1	0	0					1
400-500mm	0	3	2	0	0					5
0.5-1m	1	1	1	3	0					6
1m-1.5m	0	0	0	0	1					1

Appendix 3d

Size Range	300.1	300.2	300.3	300.4	300.5	300.6				Total
0-100mm	0	3	12	0	1	8				24
100-200mm	0	5	5	5	0	1				16
200-300mm	3	2	4	4	2	2				17
300-400mm	2	2	0	2	0	1				7
400-500mm	1	1	1	1	2	0				6
0.5-1m	0	0	0	0	2	0				2
1m-1.5m	0	0	0	0	0	1				1
Size Range	320	320.1	320.2	320.3	320.4	320.5	320.6	320.7		Total
0-100mm	1	0	17	23	0	2	6	0		49
100-200mm	3	0	4	7	2	0	5	0		21
200-300mm	2	0	5	6	3	0	2	3		21
300-400mm	0	0	1	0	2	1	0	0		4
400-500mm	0	0	0	0	1	1	0	2		4
0.5-1m	0	1	0	0	0	0	0	0		1
1m-1.5m	0	0	0	0	0	1	1	0		2
Size Range	340.3	340.4	340.5	340.6	340.7	340.8				Total
0-100mm	8	10	8	6	0	0				32
100-200mm	3	5	3	5	0	2				18
200-300mm	4	1	4	0	0	2				11
300-400mm	2	3	0	0	0	0				5
400-500mm	0	0	2	0	0	0				2
0.5-1m	0	0	0	1	1	1				3
1m-1.5m	0	0	0	0	0	0				0
Size Range	360.1	360.2	360.3	360.4	360.5					Total
0-100mm	7	12	6	11	3					39
100-200mm	0	5	2	6	2					15
200-300mm	4	1	1	0	3					9
300-400mm	1	1	2	0	0					4
400-500mm	0	0	2	0	1					3
0.5-1m	1	0	0	0	0					1
1m-1.5m	0	0	0	0	0					0
Size Range	380.1	380.2	380.3	380.4	380.5					Total
0-100mm	6	13	0	6	15					40
100-200mm	4	3	0	2	2					11
200-300mm	0	1	0	0	0					1
300-400mm	2	2	0	0	0					4
400-500mm	1	0	0	1	1					3
0.5-1m	0	1	1	0	0					2
1m-1.5m	0	0	0	0	0					0

Appendix 3e

Photographs at the Lowest Level							
Size Range		Total		Cumulative Frequency			
200-300mm		34		less	300		0
300-400mm		30		less	400		34
400-500mm		14		less	500		64
0.5-1m		10		less	1000		78
1-1.5m		1		less	1500		88
				less	2000		89
				middle value = 44.5			
Photographs at the Highest Level							
Size Range		Total		Cumulative Frequency			
200-300mm		31		less	300		0
300-400mm		15		less	400		31
400-500mm		12		less	500		46
0.5-1m		9		less	1000		58
1-1.5m		2		less	1500		67
				less	2000		69
				middle value = 34.5			
Photographs at the Middle Level							
Size Range		Total		Cumulative Frequency			
200-300mm		54		less	300		0
300-400mm		20		less	400		54
400-500mm		18		less	500		74
0.5-1m		9		less	1000		92
1-1.5m		1		less	1500		101
				less	2000		102
				middle value = 51			
All Photographed Samples							
Size Range		Total		Cumulative Frequency			
200-300mm		224		less	300		0
300-400mm		109		less	400		224
400-500mm		68		less	500		333
0.5-1m		59		less	1000		401
1-1.5m		14		less	1500		460
				less	2000		474
				middle value = 237			

Appendix 4 – Photograph of Strata on Filey Brigg, taken at Agony point

Glacial Till

a) Oolitic Limestone

b) Oolitic Sandstone

Sandstone beds previously quarried for building stone.

Of the stone samples taken from underwater rocks on Spittals, 83% matched the strata marked a) and b) in the photograph above.