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This year’s AGM will be in the ancient market town of Alnwick on Saturday 11 May. Full details are on the insert mailed with this issue. The talk will be given by the artist Karen Rann, on the evolution of contour lines; those who heard her last year in Cambridge will know what an entertaining and informative speaker she is.

The day provides the opportunity to meet and chat with other members and the afternoon map-market is a chance to browse, buy and sell second-hand maps.

Special attractions this year will be the availability of CCS publications at greatly reduced prices, a boat trip to the spectacular Farne Islands bird reserve (where the puffins should then be nesting) and a conducted tour of the historic town.

This is all detailed on the insert. If you would like to attend, please be sure to return the slip, with appropriate payment, to Bernard Anderson at the address opposite before 21 April. Numbers are limited on the boat trip and town walk, so early booking is strongly advised. For any queries, email visits@charlesclosesociety.org.

Other forthcoming events are on Thursday 20 June, afternoon visit to Royal Scottish Geographical Society, Perth; Friday 21 June, morning visit to Glasgow University Library map collection and a return visit to Dennis Maps, Frome, in early July. For information and bookings contact Bernard Anderson by phone or email.

If you haven’t renewed your membership for 2019, please do so now. Details are inside the back cover of this issue.

Our special discount arrangement with Ordnance Survey have been extended for another year. For 25% off most paper map products, including Road and Street and Wallmap, use code CC2PMGAMCM at checkout on the OS website.

In response to requests from readers, Sheetlines is now mailed in bio-degradable packaging. You should compost the wrapper rather than add to landfill.

**Join the Team!**

We are looking for members to become involved in joining our editorial team to work on producing *Sheetlines* and developing our website and social media presence. If you love maps and are interested in any aspect of design, production, communication and the use of new technologies, we would love to hear from you. Experience is not essential – enthusiasm and a willingness to get stuck in are!

Contact the editor for more information. This is a unique opportunity to help to evolve our public image and we look forward to hearing from anybody who would like to get involved.
Map evidence for the London balloon apron 1917-1918

Bernard Anderson and Deborah Stebbing

In his article describing a mystery map ¹ Gerry Zierler included a photograph of a “balloon apron” which like the map itself prompted our interest and speculation. The same photograph appears as the frontispiece in a book written by the Commander of the London Air Defence Area, Major General E.B. Ashmore. ² The photograph raised two questions, first whether such an apron was actually deployed and second if it was, are there maps and plans to show its location and hence the location of the apron shown in the photograph. This short article outlines our findings in respect of these issues.

One possible piece of cartographic evidence is found in the section of the ten-mile map covering Southern England included in official history of the War in the Air. ³ This map shows the defence arrangements in place around London in January 1918. In addition to giving the location of anti-aircraft guns and searchlights it also shows the path of a balloon apron. This stretches from Enfield via Hainault, Ilford, Barking and Blackheath to Lewisham (fig 1). The path of the apron is shown in two colours, yellow for the sections which were already in place and black for those sections which had been authorised but not yet deployed. Two sections are shown in yellow, one north of Tottenham and a second between Ilford and Barking.

Although this map appears to confirm the existence and approximate location of the balloon apron it was produced by Ordnance Survey in 1935, one must assume for inclusion in this official history, and uses as its base the ten-mile map published by Ordnance Survey in 1925. However, Jones quotes from orders given to home defence pilots on 22 September 1917: Balloon aprons and other obstructions will be established on the line: east side of Lewisham, east side of Plumstead one mile east of Barking, east edge of Ilford, east edge of Wanstead north of Tottenham. No machines are to fly across this line during operations at a height of less than 10,000 feet. ⁴ He adds that on 23 October 1917 the Commander-in-Chief (Home Forces) stated that approval had been given for twenty aprons on a line Tottenham-Ilford-Barking-Woolwich-Lewisham subject to such alterations as experience may suggest. ⁵ Both of these provide clear evidence for at least a definite proposal for the balloon apron if not for its actual deployment.

Despite this, the authors were interested in whether cartographic material existed which was produced closer to the time that the balloon apron was being planned and established. Additionally, whether any information it might provide clarified the location of the sections indicated on the map produced almost two decades after the cessation of hostilities.

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² EB Ashmore, Air Defence, Longmans Green, 1929.
³ HA Jones The war in the air, Vol V, Oxford University Press, 1935.
⁴ Jones op. cit. p 68.
⁵ Jones op. cit. p 69.
Figure 1. Extract from ten-mile map, showing the course of the balloon apron and the location of one of the sections which was ready for action in January 1918.

Figure 2. Extract from the “black map” showing the course of the balloon apron. TNA MR 1/1907.

Figure 3. Extract of a plan of the defences at Pola from Balloon Aprons and Sites, TNA AIR 1/609/16/15/271.
One possible source came from the chance discovery of an unusual negative outline map (white detail on a black background referred to as “black map”) which though on a different scale (approximately 2.5 miles per inch) matches the information on the ten-mile map in Jones, including the path of the balloon apron (fig 2). This unusual map is a photographic enlargement of the quarter-inch London Area outline sheet originally published in 1916. It is described as a “photostat copy of the London area showing the defence against hostile air raids 17.1.18”. Close inspection showed that it comprises nine separate photographs of different sizes which have been mounted to form the enlarged map. It also suggests that the original outline map had already been annotated to show the location of airfields around London and their associated flight paths. The coloured annotation was added once the photographs had been mounted and the enlarged map assembled.

Several books dealing with the impact of bombing raids on London in the summer of 1917 mention the development of the balloon apron, for example Jones, Cole and Cheeseman, Doyle and Castle. Although a detailed account of the development of the balloon apron lies outside the scope of this article, it is appropriate to provide some background information. By early summer 1917 balloons and balloon cordons had been tried as a defence mechanism by the German forces, with the aim of preventing low level bombing. An outline for one such arrangement was found in an undated plan of Pola, a submarine base located in the northern Adriatic (fig 3). Similar defences existed in Venice and a delegation from the Royal Flying Corps had visited them in June 1917 to assess their potential value. One proposal for London appears to have envisaged a series of isolated aprons rather than a continuous screen (fig 4).

The real impetus for the development of this type of defence came with the air raid on the night of 4 September 1917. On the following day Ashmore commented on the limitations of London’s air defences and made a recommendation for a balloon apron to be considered as a further means of defence. He provided a detailed outline on 19 September by which time he had identified specific sites for two experimental sections, which if successful would form part of a line of aprons. Early indications of planning are in the form of a small tracing of a section of OS one-inch Sheet 108 (fig 5). This undated extract shows the possible locations of three balloon apron sections. It is accompanied by survey reports and field sketches for two of the proposed aprons (1 and 2) undertaken on 15 and 16 September 1917.

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6 TNA MR 1/1907.
7 We are grateful to Richard Oliver for drawing our attention to this.
8 Note in TNA AIR 1/512/16/3/62.
9 HA Jones *The war in the air; Vol V*, Oxford University Press, 1935.
13 C. Cole, E. Cheeseman, op. cit.
14 LADA/157 dated 5 September 1917 in TNA AIR 1/609/16/15/271.
15 LADA/157 dated 19 September 1917 in TNA AIR 1/609/16/15/271.
16 London and Epping Forest extract tracing in TNA AIR 1/609/16/15/271.
Figure 4 (top left) Proposed balloon defences to the east of London, Home Defence; Proposed Apron Scheme and Establishment, TNA AIR 1/2051/204/379/3.

Figure 5 (above) Extract from tracing of a section of OS sheet 108, TNA AIR 1/609/16/15/271.

Figure 6 (top right) Extract from sketch showing the location of Balloon Apron number 2, TNA AIR 1/609/16/15/271.

Figure 7 (right) Extract from the section of half-inch map, TNA AIR 1/609/16/15/271.
by members of the Free Balloon Section of the Royal Flying Corps. The plan for one of these, Number 2, is shown in figure 6.17

Details of deployment are found in the document L.A.D.A/157 18 received by GHQ Home Forces on 5 October 1917; “… the first of the two balloon aprons for which personnel were sanctioned … has been installed and is in successful operation.” The same document goes on to state: “the approximate positions of the proposed aprons is as shown on the attached map.” The attached map is a section of OS half-inch sheet 34 which has been cut to slightly larger than foolscap size, the right edge of the map section has been folded in and with the passage of time has become damaged with the result that some of the hand-written text has been lost (fig 7). The top margin of the map includes a typed heading: “The suggested Balloon-Aprons will be installed at intervals along the red line. The two blue lines numbered 1 and 2 indicate the position of the existing APRONS.”

In the event, the installation of balloon apron sections was slower than had been anticipated, by January 1918 only three had been deployed and at the end of hostilities only ten of the twenty sections planned had been put in place.

The reports, field sketches and maps, all confirm the existence of a balloon apron. Additionally, there is at least one report of a German plane striking one of the apron sections which had been installed north of the Thames and reported general concern among German airmen about the apron sections and their locations.19 However, unfortunately the cartographical evidence is inconsistent, the sketches and annotations, most notably the extract from half-inch Sheet 34 and the ‘black map’ give conflicting information concerning the location of the sections and the overall path of the apron.

Turning to the photograph contained in Ashmore’s book and included in the article by Gerry Zierler, the Imperial War Museum has the negative 20 but does not possess any contemporary prints. However, this implies the possibility of it being an official photograph of a section of the balloon apron. We found only one reference to such a photograph. In a letter describing the apron, the commander of Number 7 Balloon Wing includes the comment: ‘Attached please find a photograph of the apron in the air at 2000 ft’ 21 Unfortunately, the photograph itself is missing from the file.

Our hypothesis is that the photograph alluded to in this letter is the one used as the frontispiece in Ashmore’s book and is probably Apron 2 – the first to be installed and the most likely to be the subject of an official photograph. Some support for this comes from entries in Ashmore’s diary, on the 26 September 1917 he inspected the balloon apron in Barking and then paid further visits linked with testing before gaining approval for the scheme on 21 October 1917.22

Although initially there seems little in the photograph to indicate its position, closer examination reveals the tell-tale trail of steam from a train. Above that in the middle distance is what appears to be the junction between Barley Lane and Hainault Road and closer to the bottom of the picture Green Lane and its junction with Bennetts Castle Lane (fig 8), details which suggest the location as being Apron 2.

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17 Reports of positions 1 and 2 in TNA AIR 1/609/16/15/271.
18 LADA /157 in TNA AIR 1/609/16/15/271.
19 Extract from the report on examination of prisoners captured on the night of May 19/20, 1918; LADA/157(ii) in TNA AIR 1/609/16/15/271.
20 Home Defence Balloon Apron IWM Q61156.
21 TNA AIR 1/609/16/15/271.
22 Private papers of Major General E B Ashmore IWM Docs 11911.
Midlands Group ‘Show and Tell’ evening

Lez Watson showed official mapping from many west European countries. His selection demonstrated not only wide variations in styles of presentation, but also highlighted how legends and symbols reflect local priorities. The large number of water-related features on Dutch maps might be expected, but the identification of doctors’ houses on maps of Iceland was more surprising, no doubt a reflection of the realities of life in such a sparsely populated country.

Phil Pearson had the largest offering of the evening, a bound set of 1940s six-inch maps (Provisional Edition with National Grid) of south Lancashire, annotated by the Lancashire United Transport bus company for calculation of fares, and mileages for Fuel Duty Rebate, when operating local bus services in the area bounded by Manchester, Liverpool, Bolton, Wigan, St. Helens and Warrington. Phil became custodian of the maps after LUT was absorbed into Greater Manchester PTE.

David Walker offered another example of how annotation can add to a map’s interest. A One-inch map of part of Aberdeenshire, with the name of a house underlined by a relative, revealed where he had spent part of the Second World War as a young boy. He retained memories of the experience, but until the map was passed down to him, had not known the exact location.

Bill Henwood brought a pair of World War Two-related items. Unlike the metricated and coloured series of 1938-40, a German monochrome 1:100,000 enlargement of coloured OS half-inch sheet 15 of 1937 retained the OS legend and publication information, to which German text had been added, resulting in a curious hybrid. From the Allied side, the second edition of the English Channel Handbook was published by The Hydrographer of the Navy in March 1944 ahead of D Day. Its 500+ ring-bound pages of charts, photographs, views and navigation data cover both sides of the Channel and beyond, but with no mention of the war, except for one chartlet showing a minefield, which seems to have escaped the censor’s notice. Bill also showed the 1909 edition of Bartholomew’s Two-inch map of the Road Surfaces of London, the colouring of which demonstrates how many of the capital’s streets were once paved with wooden blocks to deaden the sound of horseshoes.

The next Midlands meeting will be at Wall on Wednesday 8 May 2019, with the theme of ‘Mapping of canals’. For more information contact Lez Watson at lez@watsonlv.net.
Odd rocks in the Outer Hebrides
Michael Spencer

Certain rocks and clusters of rocks exist off the west coast of Scotland that are not shown consistently at all scales on the map. Before pointing the finger at the OS, we should perhaps decide what we want the map to show. And as usual, with any question relating to the sea, we have to start with the tides.

1. Tides
It is well known that the diurnal variation in the height of the tide is a result of the gravitational fields of the sun and the moon, their effects moderated by the motion of the earth in these fields. It is perhaps not always realised that meteorological processes, and the shape of the sea bed leading to resonances in the tidal flow, have their influences too: for example, a good Atlantic storm makes the whole concept of “sea level” no more than what is technically called a “mathematical fiction.” It is of course perfectly reasonable simply to look at the results, without worrying about the causes, and to make a table of average heights as observed over some defined period. This is what the Ordnance Survey did in arriving at the average height of mean sea level, MSL, at Newlyn near Penzance, making a measurement of the height of the tide every hour for the six years from May 1915 to April 1921. The eventual mean figure, after some corrections, was taken as the Ordnance Survey Datum, and is the value to which all heights on the mainland of Great Britain published by the OS are referred.

Clearly the height of the tide is below this datum half the time, which could lead to a difficulty of presentation. In the Bristol Channel the range of the tide, the difference between the heights of low tide and the next successive high tide, can be more than forty feet, the third highest in the world, so that the low tide mark will be twenty feet below mean sea level. Suppose there were a substantial rock in the sand at or close to the low water mark, say fifteen feet high. If the OS wanted to show the height of the top of this rock, the printed figure would have to be negative. Not pretty. The OS avoids this problem by closing its eyes; but the mariner needs to know things like this. He doesn’t want to be surprised by such an obstruction if the tide is just high enough to hide it. What can he do?

The mariner doesn’t use the OS map: he has his own map of the sea bed, called a nautical chart and published by a different arm of government, the Hydrographic Office—the clue’s in the name. The chart takes into account the whole range of the tide under normal meteorological conditions, and chooses a datum which is as low as the sun and moon working together can force the sea level to be. This is called the Lowest Astronomical Tide, LAT, below which the tide will go only under extreme storm conditions, which happen so infrequently as to be disregarded and whose results are anyway unpredictable. All depths of water shown on the chart, and all tide tables which show height of the tide anywhere at any time, are referred to LAT, so that the depth of water under the keel can be quickly found by adding the two together and correcting for the draught of the ship. There are no negative heights anywhere.

The concept of range of the tide, which is cyclical between limits for a particular place, is not to be confused with the height of tide, a time-dependent variable which is the height of the sea surface at a given moment above chart datum. The chart shows LAT instead of low-water mark, though the two are sometimes almost indistinguishable; the district between LAT and the high-water mark is coloured green.
The chart isn’t always totally reliable, though it is updated when a vessel discovers an uncharted rock the hard way. There are a number of eponymous names in this morose category, as for example Whale Rock near St Kilda and Muirfield Seamount in the Indian Ocean—the latter must have been one heck of a surprise to the MV Muirfield, for she damaged her keel in an area where the chart suggested that the water was about three miles deep. This leads us to speculate that no ship of that size (180,000 tons deadweight, draught about 55 feet, which is a pretty big ship) had ever been in that bit of ocean before, and neither had any ship with a working echo sounder, and we can go on to philosophise about how big the ocean really is, and how unfrequented, and by similar excursions through “gardens of bright images” we can begin to realise how tenuous a hold philosophers have on the real world, and therefore—ah, nuts, back on the horse.

2. Geodesy

It is well known that the shape of the earth is that of an oblate spheroid, that is an almost spherical object exhibiting a degree of flattening at the poles, the points where its axis of revolution intersects its surface. Its figure, however, is not wholly regular, but rather is modified by hills and valleys on a grand scale: the continental mountain massifs and the abyssal basins of the sea. In order to accommodate these irregularities into the mathematic basis of their maps, cartographers have posited the concept of the ellipsoid of revolution, a mathematically regular figure which as closely as possible approximates to the fundamental almost spherical surface.

The representation of heights on the map must be referred to a datum surface, which ideally would be that of the ellipsoid; but any datum would do so long as it remained always parallel to the ellipsoid and so long as its departure from the ellipsoid was known. The problem of the determination of the ellipsoid is the province of geodesy, and was essentially solved by the beginning of the nineteenth century.

Once the Ordnance Survey datum had been established, surveyors carried it forward through the country, using levelling techniques dependent in the end on the spirit level. This is a device controlled by gravity, and its function is to mark the direction at right angles to the force of gravity at a point: two such devices themselves at right angles can define a plane, the horizontal. Because of the mass anomalies set up by the existence of the masses of the continents and the depressions in the crust where the oceans lie, the pull of gravity is to a slight degree deflected locally away from the direction of the centre of mass of the earth, so that the horizontal is not always parallel to the ellipsoid.

The horizontal therefore defines a surface which is in effect a smoothed version of the irregular figure of the earth: this surface is called the geoid. Because there are no masses above the surface of the sea (if we neglect the relatively insignificant mass of the atmosphere), the mean level of the sea is part of the geoid. In the continental areas the continuation of the geoid is an imaginary sea-level surface.

The vertical distance between the surface of the ellipsoid and the surface of the geoid may under continental mountain structures be as much as a mile; under Britain, with its much less massive structures, the difference is at most a metre or so. The difference is important anywhere, because the datum follows the geoid while the computations can only be carried out on the ellipsoid. The determination of the differences worldwide was the geodetic problem of the twentieth century, finally solved only by the use of artificial satellites.
A further difficulty arose because the surveying techniques of the early twentieth century were not able to carry the datum forward across a wide expanse of sea. Altitudes in the Outer Hebrides therefore, were expressed relative to a local datum, marked by a bolt in the wall of Bank Street Wharf in Stornoway harbour at NB 4228 3264. Such local datums, derived from a shorter and less intensive series of observations than those at Newlyn, are also in use for most other major island groups, and for Northern Ireland. The differences between local datums and OS Datum at Newlyn have not been established. One might have thought that this problem could be resolved by the use of GPS, which again relies on artificial satellites: but it seems that the vertical discrimination that can be achieved is not sufficiently precise.

3. Depictions on the chart
Now we need to consider how islands and rocks are shown on the chart. There are three classes. The first comprises those features which are visible at all states of the tide: they range from Great Britain itself, the eighth largest island in the world, to tiny things like The Clach in Millport Harbour, which shows just two feet of unattractive, black rock above local high water. All of them are characterised by exhibiting a high-water mark. On modern metric charts the area above the high-water mark is tinted buff. I suggest that the map needs to show all of them, if the scale allows.

Secondly there are those features which the chart annotates as “dries,” which means that they are visible at chart datum, if the tide gets that low, and up to some point above it in the range, but are completely covered at or before high water. In the real world, they probably only “dry” in strong sunshine. On the chart, they are green islands with no buff area. Their height above chart datum, the drying height, is shown by an underlined figure. Obviously they don’t show a high water mark, but equally obviously they protrude from the lowest water level and are islands at that time. One could take up a position on one of these at low water, and wait to drown as the tide rises. (Pirates were sometimes persuaded to do so.)

Finally, the chart shows rocks which are “awash at chart datum,” that is, only if the tide gets down to that level can they be seen. The most exciting one of these is Hasselwood Rock about 200 yards north of Rockall, which the Sailing Directions says “has been seen in the swell of the waves,” a phrase designed to send shivers down any navigator’s spine. Since these are always covered under normal circumstances, they need not trouble the mapmaker. (Nevertheless, Hasselwood Rock must exert some sort of dreadful fascination for the Ordnance Survey, for it is marked on the Rockall insets on both Explorer 454 and Landranger 18. As may be expected, the level of detail is not great.)

4. Depictions on the map
Use of the “mean” sea level, identified as the Ordnance datum, completely obscures the very complex actual changes in the level of the tide, which varies between limits in various cycles which vary in length from about 12 hours to about 18 years. By far the most important of these cycles is the M2 or lunar semi-diurnal cycle, which is about 12 hours and 25 minutes long, a figure arising from the time the earth takes to rotate once with respect to the moon. During this time, the tide cycles from a maximum level to a minimum level and back again. Because the moon is moving with respect to the earth during this time, successive maximum levels are not identical: the two high tides a day are unequal, and the pattern is repeated the next day, but with slightly different values.
When the earth, moon and sun are in the same straight line, the gravitational effects of the sun and the moon complement each other, and the tidal range is a maximum: this is called a *spring tide*. At this time, the difference between the two daily high tides is also a maximum. Two weeks later, when the vectors from earth to moon and earth to sun are at right angles, the tidal range is a minimum (*neap tides*): the difference between the “morning” and “evening” tides is the least, perhaps even zero. Because the distance of the moon from the earth varies, it can happen that spring tides occur just when the distance is least. These are called *perigean* spring tides, and the range and the departure from the mean are a maximum.

The Ordnance Survey does not concern itself with determining and plotting the outside range of the spring tide. Instead, it uses an average value, called mean high- and low-water mark (MHWS, MLWS). These levels are important to the Ordnance Survey, because anything between them (the *foreshore*) is the property of the Crown, and because the low-water mark is taken as the *extent of the realm*, the baseline for territorial waters, which legally extend for 12 nautical miles out to sea. The idea of the “foreshore” is clear enough when we consider holidaymakers innocently enjoying the sand in their picnics on the beach, but seems to have little meaning when we consider the vertical sides of a sea-stack like, for example, the five-hundred-foot Stac Lee off Boreray in the St Kilda group.

Richard Oliver has published an interesting note ¹ that explains the basis for the Ordnance Survey’s fixation on mean values. By the late 1840s the lines of high and low spring tides were being shown, but in 1854 the definition of the foreshore was legally determined as the area between the mean tide lines. This was based on an opinion of Sir Matthew Hale (1609-1676), to the effect that the areas above the average high and low water marks were respectively covered or exposed less often than those lying between the two averages and were therefore of less interest to the Crown.

It seems to me, and reading between his lines I suspect it seems to Richard Oliver also, that the unthinking adoption of this seventeenth-century opinion has damaged the Ordnance Survey’s continual struggle to achieve precision. As Richard says, “[f]rom the point of view of many map users it was inconvenient, as a line of ‘ordinary’, ‘medium’ or ‘mean’ tides is often hard to identify on the ground . . .”

Fixing the high-water mark by survey is reasonably straightforward, for it is marked by a line of seaweed and small stones, pushed as high up the beach as the tide can reach. Finding the low-water mark is a different line in the sand altogether, because it leaves no trace of itself and until the advent of aerial photography using infra-red light surveyors risked wet feet or worse. In the forty-foot tides in the Bristol Channel, the water comes in across the gently shelving sands at Weston-Super-Mare faster than a man can run. Although MLWS is shown by the OS, it has only a very ephemeral reality.

I feel that a clear statement of the low-water mark would be better achieved by the OS’ adoption of LAT as a lower limit of the tide, not least because it is dependent entirely on the motions of the sun and the moon, and can be precisely calculated rather than needing to be surveyed. Presumably an Act of Parliament would be required, to give a legal basis to the new definition of the foreshore. One must admit that LAT varies by place, and does not give the single nation-wide altitude datum that the OS requires, so that OS Datum would remain in effect.

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¹ ‘The adoption of ordinary tides’, *Sheetlines* 91, 46-48.
When we consider drying rocks, we arrive at a difficulty due to the different datums of the chart and the map: if such a feature dries only a small amount, it won't reach mean sea level, so its “OS altitude” is negative and the map will not show its height. There is no reason why the map should not show the position of everything down to the low water mark, though, using the conventional sign for “flat rock,” as in fact it frequently does, since they are real islands if only part-time. Perhaps the OS needs a new symbol, or some other unmistakable method of showing less-than-MSL items.

As things stand, we need to be able to determine low-water mark on the chart, and hence the necessary “drying height” for a rock to break that line. This is easily done, for the chart explicitly tabulates the height of both MLWS and MHWS above chart datum, at selected ports on the chart. Thus anything whose drying height is greater than the height of Mean Low Water Springs should be shown on the map: objects with a lesser drying height can be ignored.

Further than this, it is valuable to be able to identify those features which dry above the Ordnance datum, for these will have a positive height. Again, for most of the same selected ports, the chart tabulates the height of the Ordnance datum, local or Newlyn as appropriate, above chart datum. A positive height is therefore found by subtracting the height of the Ordnance datum from the charted drying height. It is one of the aims of the present paper to present a list of such “OS heights”, and to distinguish them we show them in red. They are presented here to the nearest 0.1 metre, because such precision is available; if they were printed on the map, they would doubtless be rounded to the nearest metre.

5. Salient differences between chart and map

It should be noticed that the Admiralty charts refer altitudes to mean high water of spring tides, MHWS, in the local district, while OS altitudes on the mainland are always referred to mean sea level about 100 years ago on the south coast of Cornwall, which at 500 miles away could be said to have no real relevance to present-day conditions in the north-west of Scotland, even on the mainland, let alone on islands well out to sea. We must not forget the process of geological change, which in Britain has depressed the western coastline and raised the general relative level of the sea by about 0.2m (seven or eight inches) since the Newlyn datum was established.

On the chart, MHWS is itself referred to LAT in the local district. LAT is not a fixed level, but varies from place to place, largely as a result of variations in the shape of the sea bed and the resultant forces acting on the tidal movements. As noted above, the difference between LAT and OS Datum, local or Newlyn as appropriate, is tabulated on the chart for various places, mostly ports currently in use.

The chart explicitly shows both LAT, on a modern metric chart the border between blue and green, and MHWS, the border between green and buff. It therefore shows, and uses, two different datums at the same time, for different classes of feature, which needs clarity of thought.

On the other hand, the map shows both MHWS and MLWS, and MSL can be taken to be half-way between them in terms of height. But unless the slope between them is absolutely uniform, we cannot confidently infer the position of the line of MSL, and so we cannot draw it on the map; and in fact the map does not attempt to show it. Thus the map refers altitudes to a datum which is not drawn explicitly, a curious state of affairs to say the least.
To show the differences in rock drawing between the map and the chart, Figs. 1 to 4 are extracts from, respectively, *Landranger* (LR) No. 31 at 1:50,000, latest revision 2002; Chart No. 2770 at 1:30,000, latest revision 2016, but *in this area* 1911; *Explorer* (EX) No. 452 at 1:25,000, latest revision 2002 (my apologies for the dense fold in this one); and six-inch sheets Hebrides Nos. 60 and 61 at 1:10,560, latest revision admittedly much earlier at 1901; all showing part of the Sound of Barra, between the islands of Eriskay and Lingay (Lingeigh, the Gaelic spelling, on LR). The extracts are placed in this order to enable quick comparisons to be made, and it is expected that most comparisons will be made between adjacent pairs. The scales are adjusted to appear to be the same for all extracts, and to fit comfortably on the A5 sheet: it works out at about 1:25,000. The point where the causeway reaches Eriskay is NF 784124.

Chart 2770 states explicitly that MHWS lies at 4.2m, MLWS at 0.6m, above LAT, from which we deduce that MSL in the Sound of Barra is 2.4m above LAT. Remember that the local OS datum is 2.7m above LAT. Because of this difference, 0.3m or about one foot, it is possible that the lines of mean high and mean low water as shown on the map are wrong by that amount.

The differences between rock drawing on the four extracts are very marked. All four agree on the existence of the tiny islet named on the chart as Grianameal; but only *Explorer* agrees with the chart on the two minute yellow points close to the south-east corner of it, the other two unable to show any corresponding feature; and even *Explorer* disagrees with the chart about the existence of the tiny yellow point half-way to Lingay, while showing a tiny blue line (indicating HWM) close to NF 761116, an islet unknown to the chart.

The continuous areas bounded by LAT are shown on LR and EX as collections of tiny individual rock areas, which seems to indicate that the LAT-island is criss-crossed with channels dividing the rocks into areas each more than two feet above LAT. The user of the map is invited to consider how likely this is. The numbers shown seem to
depend on the scale of the map, with EX showing almost but not quite every green area more than a simple dot, while LR shows only those of more than some lower limit of area on plan. It would be very helpful if the map indicated explicitly what boundary is being shown. Neither LR nor EX gives a height for any point on a green area, not even those which the chart shows as drying more than 2.7m and therefore protruding above the Ordnance datum.

The six-inch shows the rock areas, where they are shown at all, apparently down to the line of LAT, and accentuates those areas given a rocky edge by the chart. There is no sense in which this edition of the six-inch can be said to be a data source for the smaller-scale maps, and we shall consider it no further.

The OS shows the high-water mark on Landranger by a continuous black line, on Explorer by a continuous blue line which is sometimes difficult to see against the background of rock drawing. The Admiralty plots HWMS as the lower limit of the buff tint, quite unlike any colour used by the OS. The great similarity between the two organisations' views of the high-water mark is covered by the note on the chart that "the topography is derived chiefly from Ordnance Survey maps", but the differences in datum result in a systematic difference of recorded heights.

Differences in spelling, caused by the OS' attempts to get the Gaelic spellings correct and the Admiralty's insistence on spell-as-you-speak, are remarked on where they could cause confusion. The Admiralty states that its spellings are "in accordance with the principles and systems approved by the Permanent Committee on Names for British Official Use." It seems unlikely that this Committee includes a Gaelic scholar. In fact, it always surprises me that speakers of English seem to consider it somehow beneath them to attempt to spell correctly any names in the other two languages indigenous to these islands. A good example here is a rock drying 0.6m, so probably never appearing much above MLWS, for which the Admiralty uses the part-French-looking “Bo Vich il a Vhetur,” which seems likely to be a corruption of “Bogha Mhi-chiall a’Bheithir,” loosely translatable as Wild Animal Rock. The Admiralty provides many more names (usually in English translation) than does the OS, and these are used here to give some individuality to the features listed.

6. Unmapped rocks

So we need now to decide what we are going to look for, what islands and rocks we can reasonably ask to be added to Landranger and Explorer. Having regard to the differences between the four extracts considered above, our conclusions might be that anything Explorer doesn't show will almost certainly be below MLWS or well out to sea, while Landranger shows only the features larger on plan, as is appropriate to its smaller scale, but doesn't offer a defined boundary for its indications.

This means that we can reasonably provide a list of rocks drying above MLWS that are not shown on Explorer. By definition, drying rocks do not reach MHWS, and so they should appear as rock drawings without the blue line. Those which will appear above the local (Stornoway) Ordnance datum should be specially remarked, by showing in red their "OS height", which is the amount by which they exceed that datum. In some cases, the chart does not tabulate the local OS datum, and here we need to make an informed

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estimate, or even remark only on the drying heights above local MSL. The limitations of Landranger make such a list less appropriate. But for both maps, we can look for genuine islands not shown on the map, reaching above MHWS on the chart. On Explorer, they will need the blue line; on Landranger, they may be too small to show. We do not consider that LR needs to show anything less than 100ft across on plan.

In the list posted online, therefore, we show for Explorer
- the drying height of all rocks shown to dry above MLWS, if unmarked already
- the drying height and the “OS height”, that is the height above the local OS datum, for all rocks that dry to such a height whether marked on the existing map or not
- any features above MHWS (“islets”) not already shown

and for Landranger
- any features above MHWS not already shown and larger than about 100 feet across on plan
- We show also the relevant maps and charts, with tabulated details of range of spring tides and the height of OS datum above LAT. For charts that do not give details about the OS datum, we show the method we use to work it out.

The list appears in the online version of this article, posted at https://www.charlesclosesociety.org/files/OddrocksinOuterHebrides.pdf

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BL is stumped – can we help?

We recently came across an item in the British Library collections that is a puzzle. I have asked some experts but none can identify the item, beyond the obvious similarity to the markings on a levelling stave. The item bears an embossed stamp (lower left) that identifies it as Ordnance Survey material from c1853. There is also a British Museum stamp from February 1854. Can any CCS member identify the item?

Jim Caruth, Lead Curator of Modern Mapping, British Library
**Ingleborough Cave**

_Peter Haigh_

Richard Oliver recently discussed the depiction of underground features on nineteenth century six-inch maps.¹

On the slopes of Ingleborough, Fell Beck gathers strength and then plunges over 300 ft into the open pothole of Gaping Gill. The water emerges just over a mile away at Clapham Beck Head, itself a mile above the village of Clapham. A few yards above this resurgence, the prominent entrance to Ingleborough Cave indicates an earlier site for the resurgence. This whole area is owned, as it has been for the last 200 years, by the Farrer family.

In 1837, Ingleborough Cave only extended 60 yards to a tufa barrier. The barrier was blown up by Josiah Harrison, an estate employee, under instruction from James Farrer 1812-79 and Matthew Thomas Farrer 1816-89. These two, together with various estate employees, then explored the cave beyond this earlier barrier. These activities were recorded in a ‘Cave Book’, which still exists in the family archives in Clapham. From the entrance, the cave extends some 800 yards to the Giants Hall as a fine walking passage; with the further low watery passages beyond that resisting exploration in Victorian times. Howard Beck, in his book *Gaping Gill* states that in 1838 the family commissioned Howard and Hodgson, Land Surveyors of Lancaster, to survey the cave and this survey was subsequently published.²

The Ordnance Survey surveyed this area of Yorkshire at the six-inch scale in 1846-7 and sheet CXIII [113] was published in 1851. Ingleborough Cave appears on this survey but the OS is more likely to have re-surveyed the cave than use that provided by outsiders. The cave itself is rather more boldly drawn (but with almost identical features) on the 1893 survey (published 1896) so that is the one which is reproduced here. The cave’s inclusion on the OS map has become quite well known because its presence continued for many years. Indeed it was subsequently transferred to the 1:25,000 series and is still present on my Outdoor Leisure series map of the ‘Three Peaks’ edition A of 1973.

But why did this cave appear on the Ordnance map? That initial exploration revealed spectacular formations, so the cave was always gated to protect these and only open to the general public on payment of a fee; not apparently a prime candidate for such OS publication. The consensus seems to be that there was some family connection between the Farrer family and the military, but closer examination only reveals a range of possibilities.

First, the alleged connection between Matthew Farrer and one of the daughters of Colonel Lewis Alexander Hall, Superintendent of the OS from 1847-1854, appears to be incorrect. Matthew was married twice, first to Frances Golding, who died in 1844 and secondly to Mary Anson, (great-great-niece of the redoubtable Admiral Anson,³ another military connection). The elder brother, James, who was involved

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¹ Sheetlines 113, 19.
with Matthew in the initial exploration, never married. Secondly, the local historian, Ken Pearce, reports ⁴ that in discussion with Dr John Farrer (1921 – 2014), the squire for over 60 years, the latter “…told me of this connection and link himself. He seemed certain of their genuineness.” Thirdly, Oliver Farrer (1742 – 1808), grandfather of Oliver and Matthew, was married to Anne Fawcett, daughter of General Sir William Fawcett, then supreme Commander of the British Army. Howard Beck’s book gives this as the linkage to the OS.

As Ken Pearce states “You pays your money and takes your pick!”

Richard Oliver adds: I am sceptical whether OS would have used a private survey like Howard and Hodgson’s. I think it more likely that there was either some uncertainty as to what was ‘public’ enough to be mapped (possibly the ‘Beddington tunnel problem again!), or that it was at the initiative of the OS local officer, Capt Hamley (see footnotes to Yorks 113): a similar interest in deserted villages in the East Riding a few years later accounts for careful mapping of their remains by surveyors under Capt Bayly. ‘Connections with the military’ need to be handled carefully: the Board of Ordnance was separate from the Army until 1855, nearly a year after Hall left the OS. I plump for Capt Hamley!

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⁴ Personal communication, 31 December 2018.

Further to the feature in *Sheetlines* 113 (page 37), Keith Jameson, who worked for Thames Conservancy before the water industry was privatised, sent the scanned image above. The map is at scale of 8 miles to one inch and is dated January 1965.

Meanwhile Bill Henwood sent the map opposite and comments: “Nominally at quarter-inch scale, it measures 21 x 25 inches and is in the snappily-titled “*Trent River Board Pollution and Fisheries Department Second Quinquennial Abstract of Statistics relating to River Surveys in the Trent Watershed covering the five-year period 1957 to 1961 (with some Supplementary data for 1962)*”, published in 1964. No doubt there will have been similar for other major catchments. The good news is that most sections shown as ‘dead’ on the map now support good angling and much wildlife, including otters.”
TRENT RIVER BOARD

DIAGRAMMATIC MAP OF THE RIVER TRENT AND ITS PRINCIPAL TRIBUTARIES

Showing the approximate quality of the streams in terms of the biological conditions and some of the average chemical figures over the three year period 1959 - 1961.

Approximate Scale — 1 mile to the inch

Legend:
- Blue: Good
- Green: Fair
- Yellow: Poor
- Black: Very Poor

Note:
The last 30 miles of the Trent is subject to sewers and packer works and for the purposes of sewage plants and industrial works the estimate is given in the map.
An uphill struggle: the contoured map of the Thames basin

Bill Henwood

When invited to speak about the 1870 Contoured Map of the Thames Basin at the Midlands group meeting in September 2018,1 I posed four questions: why was it produced, what does it depict, how was it compiled, and what might it tell us about the progress of the Ordnance Survey at the date of its publication?

The first of these was answered by the late Tim Nicholson in Sheetlines in 1991.2 In the third quarter of the nineteenth century, London and other major cities in England were experiencing rapid population growth, coupled with rising industrial and per capita domestic use of water. Fears that demand would outstrip supply led to a Royal Commission on Water Supply which sat between 1867 and 1869. 66 maps, plans and diagrams accompanied the Commissioners’ report, eight being produced by the Ordnance Survey. The Contoured map of the Thames basin is one, Rivers and their catchment basins another.3

The Contoured map is at quarter-inch scale (1:253,440), in landscape format, about 38 x 21 inches within the neat line (see above). It covers the Thames catchment area and its estuary, extending to Orford in Suffolk and North Foreland in Kent.

1 Sheetlines 113, 4.
Depiction of detail is selective. London is drawn to scale and its size is as on the original One-inch Old Series sheets 1 and 7, published in 1805 and 1822 respectively. Later revision of sheet 1 showing the growth of east London and the docks has not been incorporated, which is odd, considering the reason why the Contoured map was being produced. All other settlements are identified by small open circles, but many are unnamed.

Railways are represented by single lines, with the network as at about 1860 rather than 1870. Rivers are shown by fine single or double lines, and major streams are named; those within the Thames Basin are hand-coloured in pale blue, as is the sea. Canals have double lines; most are named but uncoloured. Other than in London, no roads are shown. A variety of solid and dashed lines, and circles, denote relevant geological and hydrographic information.

Within the Thames catchment, whose boundary is marked by dashes, relief is shown by layering and ‘shaded’ or ‘illuminated’ contours. Layering in engraved shades of grey begins at 100 feet, darkening progressively at 200, 400, 500, 600, 700, 800 and 1000 feet, the last of which is almost black. Combined with contours accentuated on south-east facing slopes, the desired three-dimensional effect depends on the optical illusion produced by lighting from the north-west, but the topography of south-east England is not helpful. The Cotswold and Chiltern escarpments face north-west, with their dip slopes trending south-east. The effect works better on the south facing escarpment of the North Downs and in The Weald.

Printed beneath the map title, ‘Contours at 100 feet vertical interval (only approximately correct)’ is an understatement: their accuracy varies markedly. The Cotswolds correctly rise to 1000 feet, though their slopes, and those of the North

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4 Railways shown include: Henley on Thames branch (opened 1857), Chipping Norton branch (1858), Watford to St. Albans (1858), Sittingbourne to Sheerness (1860), and Faversham to Whitstable (1860). Absent are: Abingdon branch (1856), Luton to Dunstable (1858), Welwyn to Hertford (1858), Welwyn to Luton (1860), Chappel to Halstead (1861), and Whitstable to Herne Bay (1861).

5 Shaded or illuminated contours had been tried before, on One-inch maps of Edinburgh in 1858 and the Lake District in the 1860s. See Sheetlines 2, 6; 3, 10.
Wiltshire Downs, are very generalised. But near Oxford, Wytham Hill and Shotover Hill, both over 500 feet high, are entirely absent, while the steep escarpment of the Chilterns, which crests at over 800 feet in places, is shown only as a gentle climb to 600 feet, with no attempt to reflect the intricate hachures of spurs and combes on the Old Series One-inch map. By contrast, both the heights and slopes of the North Downs and adjacent areas are depicted quite accurately, such precision extending as far west as the Goring Gap between Oxford and Reading.

Materials to compile the map were limited. OS did not produce a quarter-inch series until the 1890s, so it had to be drawn from scratch. The main source will have been the Old Series One-inch. Resurvey for the New Series and larger scales had just started south of London but little, if any, new information would have been available. Another source does, however, appear to have been employed: the six-inch scale ‘Surrey Hills’ maps, surveyed, with contours, by the Royal Engineers in the early 1860s. Printed by OS, these cover an east-west strip across not only Surrey, but into Hampshire and Berkshire. Their use would explain the greater accuracy of heights and contouring of the hills in these areas.

As Tim Nicholson recorded, the map’s production was beset by delays and complications, and it did not appear until over a year after the Royal Commission report that it was supposed to accompany. With many settlements marked but unnamed, and little apparent effort to mould contours to the Old Series hachures, one might conclude that the map was completed in some haste.

The map’s print run is unknown, but by 1873 it was on public sale for four shillings. In 1909 Stanford’s could supply it cased for 7/6. It was still listed (and still at four shillings) in the 1924 OS catalogue.

What can the Contoured map of the Thames basin tell us about the progress of the Ordnance Survey in 1870? Without a quarter-inch base map or a survey with levels, it seems to have relied largely on some of the earliest Old Series One-inch mapping, to which railways had been added. Use of the ‘Surrey Hills’ material allowed greater detail and accuracy over a small proportion of the map, but this only served to highlight the paucity of information and consequent inaccuracy of contouring elsewhere. If the map had been commissioned a decade later, it would have been a different story, as most of the Thames Basin had by then been resurveyed and contoured. And if catchment areas in the north of England had been required to be mapped in 1870, the relevant detail was already available. So, it was, perhaps, the right map, but of the wrong place and at the wrong time.

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6 I am grateful to Dr. Richard Oliver for a discussion on these maps as likely source material for the Contoured Map. Three sheets were printed in facsimile by the Reproduction Division, Military Survey in 1997. See also Richard Oliver, ‘The relationship of the ‘Surrey Hills’ Six-inch to the 1:2,500’, Sheetlines 32, 2.

7 Nicholson, op cit.


9 Catalogue of Maps and other Publications of the Ordnance Survey (Southampton, 1924), 22.
London meeting – Soviet Cold War maps of London and Ordnance Survey

The London local group met at Gospel Oak to hear John Davies describe the secret Soviet military maps of London and their relationship to OS maps.

From the 1950s to the 1990s, the Military Topographic Unit of the General Staff of the Soviet army embarked on a gigantic global mapping project, producing maps at seven scales, ranging from 1:1 million to 1:10,000 of much of the world. Following the collapse of the Soviet Union, some of the maps gradually became available in the West, many by way of Latvia, where the founder of the Jana Seta map shop had purchased several tonnes of ‘waste paper’ as the Russians made hasty preparations to vacate a military map store in Cēsis in the east of the country.

In 1997 OS put out a statement claiming that the Soviet maps were essentially copied from OS maps and as such violated copyright. The purpose of the evening’s talk was to examine the small-scale topographic maps and the large-scale city plans of London and to explore the similarities and differences between depiction of landscape, buildings and infrastructure on Soviet and OS mapping.

A typical comparison can be seen in the extracts below showing Trafalgar Square, in which the Soviet map includes detail not shown on the OS sheet, such as street names, tube stations (M) and their names, colour-coded ‘important objects’, footprints of individual buildings, structural material of the railway bridge, and the nature of river embankment; omits ‘political’ information such as the name of the London Borough (LB) and uses a different classification for major roads.

Top:  
OS 1:25,000 TQ 28/38  
City of London, 1983

Below:  
Soviet 1:25,000 London sheet 1, 1985

Special thanks to Henrietta Nasmyth who hosted the event and welcomed members with a glass of wine.

Offers to host such events, in London or elsewhere, are invited. Please contact the editor if you are interested.
The Armistice was not the end of the war

John I Cruickshank

Contrary to the impression that is given every November, the First World War did not end on 11 November 1918. And even the peace treaties signed in Paris in 1919 did not stop conflict and outright warfare in many places. For example, the settlement imposed on Turkey, as the successor state to the Ottoman Empire, was simply not accepted, and only reignited fighting across the Balkans, Asia Minor and the Trans-Caucasus for several more years until the borders of modern Turkey (and likewise its ethnic and religious composition) had been established by force. Indeed one could argue that the present conflicts across the former Ottoman territories of the Middle East should all simply be considered as a continuation of the First World War that has not only not been resolved, but substantially fuelled, by successive externally-imposed settlements.¹

Such questions apart, it is unarguable that the armed forces of Britain and the Empire remained in action on several fronts in 1919. A pocket-size intelligence map-booklet Russia Route Zone A, Murman Railway and Kola Peninsula, provides a reminder of one of these campaigns.² That this booklet was produced by the Americans is only one of the disconcerting aspects of this campaign.

For centuries Russia has felt trapped by its own geography, in that despite its vast size it has never had good shipping access to the open oceans. The rise of the Atlantic powers to world political and economic domination was based on oceanic shipping and trade, and until the invention of the railway Russia could only look on with envy.³ The issue was (and is) not merely economic. Militarily, the size of Russia and the difficulties of supply and communication without easy access to the sea have been a perpetual problem to all armies and their commanders there.⁴

The port of Arhangelsk (Archangel) in the White Sea was developed in the sixteenth century as a trading port for the Muscovy Company of London.⁵ It retained its importance thereafter, and was thus linked to Russia’s railway network before the outbreak of war, however due to its position on the estuary of the (Northern) River Dvina its waters are shallow and prone to silting, and moreover

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¹ The literature is vast, and often polemical, but Michael A. Reynolds, Shattering Empires; The Clash and Collapse of the Ottoman and Russian Empires, 1908-1918, (Cambridge, 2011) offers thought-provoking insights.

² Russia Route Zone A, Murman Railway and Kola Peninsula, (Military Monograph Subsection M.I.2, Military Intelligence Division, General Staff: Washington, 1918). There were stated to be 3,000 copies of this publication. The example studied is copy no. 251, held in a private collection.

³ The classic exposition of the rise of the Atlantic sea-powers is Carlo M. Cipolla, Guns and Sails in the Early Phase of the European Expansion 1400-1700, (London, 1965), but many authors have expanded the topic.

⁴ The issue is discussed, usually at length, in every economic, military and strategic study of Russia produced from the time of Peter the Great to the present.

⁵ For a recent account of London’s role in this development see Stephen Alford, London’s Triumph; Merchant Adventurers and the Tudor City, (2017).
freeze for half of the year. Although much further north, and almost uninhabited until the twentieth century, the Murman (northern) coast of the Kola peninsula is closer to the Atlantic and therefore warmed by the Gulf Stream. It thus remains ice-free in winter.

During the First World War the main Russian port of St. Petersburg (then renamed Petrograd) was effectively closed to international traffic by German control of the Baltic Sea. The Russian imperial authorities therefore decided to develop an entirely new military port on a deep-water inlet in the north side of the Kola peninsula, to be called Murmansk. To do this rail access was required, and so (with remarkable speed) during 1916 a new single-track railway line 819 miles (1,278 versts) long was constructed linking the new port with the St. Petersburg to Vologda rail line, at its crossing of the River Volkhov south of Lake Ladoga. The terrain crossed by the route was largely un-surveyed, the northern part in particular being (according to the map-booklet) ‘a vast wilderness almost devoid of roads and settlements and until recently but little known’.6 Construction of the line was directed by Canadian engineers, lent to Russia for the purpose. The work was done by Chinese and Korean labourers and by the forced labour of German and Austrian prisoners of war, of whom 40,000 died during the

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6 At the onset of the First World War the largest scale military maps of the area were compilations made at 1:420,000 from various sources in the 1870s. VV Glushkov, El Dolgov, AA Sharavin, Korpus Voennyykh Topografov Russkoi Armii v Gody Pervoi Mirovoi Boiny, (Moscow, 1999), plate 1. FA Chernyayeva (trans. James R. Gibson), ‘IA Strelbitsky – the Foremost Russian Cartographer of the 19th Century’, Canadian Cartographer, 11 (1974), 99–106. This map series, with railway revision, remained in use by the RKKA (Red Army) until the Second World War.
project.7
As the line was completed Britain and the other western allies were acutely aware that Russia was struggling to continue the war against Germany, but were desperate to support her in doing so. As soon as the railway was operational, Britain began delivering arms and coal to the new port at Murmansk. The coal was essential, because although the Russian locomotives had been designed to burn either wood or coal, local fuel resources had been exhausted by the construction of the new line, and coal from the mines of the Donets Basin in the eastern Ukraine was too far away to be readily available.

However in February 1917 the first of Russia’s revolutions took place, deposing the Tsar and establishing a civilian government in Petrograd. Under pressure from the western allies, the new government agreed to continue the war, and agreed to prepare a further offensive against the central powers that summer. This offensive collapsed, and led to further political collapse, mutiny amongst the troops, and in November 1917, the October revolution in which Lenin and his Bolshevik party seized power. The Bolsheviks then unilaterally withdrew from the war with Germany and Austria-Hungary to concentrate on consolidating their own (initially fragile) grip on power. On 3 March 1918 however further German advances forced the Bolsheviks to accept a formal peace treaty, the Treaty of Brest-Litovsk, by which vast territories, including all Poland and the entire Ukraine with all their resources, were ceded to the central powers.

As a result of these events, in the Spring of 1918 Britain and the western allies were facing newly reinforced German forces on the Western Front while their own reinforcements from the USA were only just beginning to arrive and were not yet battle-ready. The stock-piles of munitions that had recently been built up at Murmansk (and at Arhangelsk) were also a concern, because of the possibility that they might be captured by the Finnish ‘White’ forces, who with active German support were in the process of creating an independent Finland, and who were within striking distance of Murmansk and its railway. Something had to be done to protect this materiël from German-sponsored capture.

Three days after the signing of the Treaty of Brest Litovsk, on 6 March 1918, at the request and with the written permission of the chairman of the local Soviet, 130 Royal Marines from HMS Glory landed at Murmansk. That permission had even (initially) been endorsed by Leon Trotsky himself. Further Royal Marines and some French soldiers landed from HMS Cochranec the following day. During April and May, despite objections by Vladimir Lenin, these forces engaged in joint operations with local Soviet Red Guards to secure the northern part of the railway and the mouth of the Kola Inlet against the Finnish Whites.8

The political and military climate was however shifting, and attitudes were hardening, both in London and in Moscow, to where the Soviet capital had been moved in March 1918 because of the German advance towards Petrograd. In

London Winston Churchill, then Minister of Munitions, but later Secretary of State for War, was preaching a crusade against the Bolsheviks and pushing for international military intervention to overthrow them. Military and political support for the Russian (anti-Bolshevik) Whites was to be an integral part of this intervention. When a small and very mixed international force (including American Marines) was landed at Arhangelsk at the end of July 1918 it was synchronised with a *coup d'état* against the local Bolshevik soviet, replacing it with a puppet White Russian administration. Thereafter a succession of costly but inconclusive battles took place between intervention forces and the newly established Red Army up and down the Murmansk railway and along the rivers and railway south of Arhangelsk, until the futility of the enterprise eventually became clear to all in the Summer of 1919. The last allied troops were evacuated from Arhangelsk on 27 September 1919, and from Murmansk on 12 October.

That it was the Americans who produced the geographical intelligence document for the Murmansk operation is perhaps explicable by two factors. Firstly, the basis of the map-booklet was clearly the engineering details of the railway, including many photographs, that were probably those of the Canadian engineers who had been in charge of its construction. By 1918 this material was perhaps in Canada. Secondly the desire of the United States to play a full military role in the war that it had only just joined, combined with the fact that the USA had agreed to contribute a large part of the forces involved, probably led to their being tasked to prepare material for what was no doubt seen by GSGS (and OS) as an unnecessary distraction while they were quite busy enough in France and Belgium.

The booklet is quite small (12 x 17 cm.), and is bound in buff buckram boards incorporating an overlapping flap closed with a press-stud. There are 118 letterpress pages with 54 pages of photographs on India paper, plus four fold-out maps and a single-page map. The first fold-out is an (unscaled) sketch map of ‘Northwestern Russia’ (showing Murmansk, Arhangelsk, Vologda and Petrograd). The next shows the ‘Southern Portion of the Kola Inlet’ (centred on Murmansk), with hachures to represent the surrounding hills. Surprisingly, the course of the new railway is not marked. There is a scale of miles, but no representative fraction is given. However the scale appears to be 1:84,000, which was the standard Russian 2-verst topographic scale. The third fold-out is a poorly-legible and over-reduced reproduction of a sketched ‘Map of Ekaterina Harbour’ (at the entrance to the Kola inlet). Although astronomical survey points are indicated, no scale is given. The fourth is a ‘Plan of the Town of Murmansk’ with contour lines.

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9 Kinvg, *op. cit.*, dissects the convoluted (and contradictory) British political and military factors sustaining the various British interventions in Russia at this time. For the wider background see Jonathan D Smele, *op. cit.*, Evan Mawdsley, *The Russian Civil War,* (Edinburgh: Birlinn, 2000), and Bruce Lincoln, *Red Victory: A History of the Russian Civil War,* (1989), especially 163-193. Beware *Wikipedia*: when accessed on 5 Dec 2018 the article ‘North Russia Intervention’ had been subjected to re-editing that had left it without a coherent overall narrative.

10 See *Report on Survey on the Western Front 1914-1918,* (HMSO, 1936).
at 1 sazhen (7 foot) intervals. The horizontal scale is given in yards and seems to be about 1:19,000, although the original scale may have been larger. It is a map of an intended town, and shows a grandiose street plan on the slopes above the inlet, but with only a scatter of buildings marked in quite limited areas of the town, and an incomplete state of the railway. Kinvig gives descriptions of Murmansk in 1918 as ‘a handful of log huts’ and ‘unmade roads which became a morass of mud in the short summer months’, and ‘movement on foot … by duckboard pavements with a few roads corduroyed with laid logs’. Comparison of the 1918 plan with the publicly available tourist street plan from 1989, and with Google Maps, suggests that the eventual pattern of city-centre streets was only very tenuously related to that imagined in 1916-18. The final fold-out is a map of the ‘Murmansk-Petrograd Railway and Adjoining Region’ at a scale of 50 versts to the inch (1:2,100,000), probably reduced from the Russian 25 verst Military-Strategic Map. Despite its small scale, this might have been the most useful map in the book for the rail-based campaign that was developing. The single page map is a very basic sketch diagram showing the 60 intermediate stations between Murmansk and Petrograd.

Plan of the town of Murmansk

11 Kinvig, op. cit., (2006), 19. Turistskaia Skbema Murmansk (Moscow: GUGK USSR, 1989). The planimetry of the 1989 map may not be accurate, but it corresponds recognisably with Google Maps images (accessed 12 Dec 2018). Frustratingly, the Soviet 1:50,000 sea chart 15004 Kol’skii Zaliv (Moscow: GUNO MO USSR, 1987) shows almost no land detail above the high-water mark. Note that Murmansk and its railway were not only expanded and extended during and after the Second World War, but also extensively affected by enemy action. No inter-war street plan of Murmansk was available for comparison.
How much the booklets were actually used is unclear. The copy examined is clean and unused. Its compilation date of October 1918 was well after the start of the operation, but it may have been helpful to officers and troops arriving in Murmansk as reinforcements in 1919. It was probably however little day to day use once they were there.

The significance of this map-booklet is however not only as a reminder of a campaign that was undermined from the start by unclear and unrealistic aims and objectives, and which in the long run probably did Britain more harm than good. It also appears to be an early, and perhaps the very earliest, example of the United States producing geo-intelligence for use by British military forces in joint operations. During the Second World War such intelligence provision became routine, and has further increased as satellites and remote sensing data have become central to NATO geo-intelligence provision. While both GSGS and OS seem to have avoided direct involvement in the North Russian Intervention, the precedent established for the use of American geo-data by British forces was to have an increasing impact on both British organisations. Thus, in marking the centenary of Britain’s unsuccessful North Russian Intervention, we are also marking one hundred years of British use of US geo-intelligence.

A brief history of OS and its maps, with some interesting historic photographs, appeared (for no particular topical reason) on the BBC News website on 14 October 2108.

https://www.bbc.co.uk/news/uk-england-45007577

**Ordnance Survey covers and titles update**

**Derek Deadman**

Additional items to list in *Sheetlines* 111, April 2018.

1.1 Textured red cloth. Title label, book-fold.

Known district maps: Add Winchester District.

Ireland: Known District maps. Add Dublin District.


Add sheet 37, 65

11.2.a Popular Edition. One-inch. England & Wales. Dark red and black. Location map. Series sheets except sheet 17 (pictorial cover) and 140 (place-name list). All other 144 numbered series sheets known in this cover.
Book-fold covers (‘wrap round’). Known sheets: Add 7, 18, 34, 35, 48, 51.

Known district maps: Add North London.

Add in Bender covers: Sheet 38.


Probably all 40 numbered sheets were printed with this cover. Known sheets: Add 9, 38.

12.2.a Car passing signpost. Half-inch, green and brown. England & Wales (40 numbered sheets)/Scotland (34 numbered sheets)/Ireland (25 numbered sheets) series sheets. G.R. arms. All numbered series sheets are known for each country with these arms. Covers with E.R. arms are also known to exist for maps of England & Wales and of Scotland.
Scotland adhesive covers with E.R. arms. Sheets known: 23, 26, 33


A later printing of a number of sheets bearing E.R. arms is known. Known sheets with E.R. arms: Add sheets 6, 12, 13, 14, 25.


Known hinged sheets: Add 6, 17, 37.
Bender covers. 1939-40. Known sheets: Add 4, 68, 80, 92.


Book-fold covers. Known sheets: Add 95, New Sheet 95 (St. Albans), 118, 124, 137, 139, 140, 141, 143.
Bender covers. Known sheets: Add 136, 139 (via a sticker for Seaton and District), 140.


Known: Add Belfast.
Known without spine title: Leicester.
No spine (dissected, mounted in sections. Black sheet name. 1923): Belfast.

Thanks to Graham Cornell, John Davies, Peter Gibson and Rob Wheeler for their help in the preparation of the original article and for their continuing help in informing me of additions. Thanks is also given for help in producing this update to the late Tim Bleasdale, and to Hugh Brookes, John Langdill and Michael Nolan.

Please let the editor know of further additions that can be made to this, or the original listing. Remaining errors are those of the author.

Lez Watson writes: There is a discrepancy between the reference numbers for map cover styles that I devised for the listings in my article in Sheetlines 108 and those now adopted in the Society’s online map cover collection.\(^1\) The following table shows the correlation between them.

<table>
<thead>
<tr>
<th>As published in Sheetlines 108</th>
<th>Online collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 House style 1968 (a) - (l)</td>
<td>H132.7</td>
</tr>
<tr>
<td>2 Non-photographic Landranger cover (a) - (j)</td>
<td>H301.1</td>
</tr>
<tr>
<td>3 Integral covers (1980-1986) (a) - (d)</td>
<td>-</td>
</tr>
<tr>
<td>3 First photographic cover (a) - (e)</td>
<td>H407.2</td>
</tr>
<tr>
<td>4 Second photographic cover (a) - (d)</td>
<td>H407.3</td>
</tr>
<tr>
<td>5 Third photographic cover (a) - (h)</td>
<td>H501.2</td>
</tr>
<tr>
<td>6 Fourth photographic (new specification) cover (a) - (u)</td>
<td>-</td>
</tr>
<tr>
<td>7 Fifth photographic cover (revised edition format) (a) - (b)(^2)</td>
<td>-</td>
</tr>
</tbody>
</table>

|  | House style, 1968 132.7 (a)-(g) |
| Online collection |  |
| 2 Non-photographic covers since 1978 301.1a |
| 3 Integral covers 301.1b |
| 3 Photographic covers 407.2 (a)-(c) |
| 4 Photographic covers - part 2 420.2 |
| 5 Photographic covers - part 3 440.4 |
| 6 Photographic covers - part 3 442.2 |
| 7 Photographic covers - part 5 500.3 |

\(^1\) www.charlesclosesociety.org/coversintro
\(^2\) This on continuation page at www.watsonlv.net/pdf/landranger_covers2.pdf
**Urban road fill on the Third Edition**

**Rob Wheeler**

*Introduction*

Some fourteen years ago, I observed that the selection of urban roads deserving brown fill on the one-inch 3rd edition Large Sheet Series (LSS) appeared to be based on guess-work. This was based on Lincoln where the LSS is the only coloured form of the 3rd edition. If I gave any thought to the Small Sheet Series (SSS) at that date, I assumed that a single exercise in creativity served for both.

Recently I had occasion to compare SSS 317/332 (7.07 printing) with LSS 136 (6.12 printing). It came as a surprise to find that there were differences in the urban road fill in all the bigger towns. It would seem that the brown plate for the LSS was created from scratch rather than being transferred from the constituent SSSs. That raises the question of whether the LSS plate was an improvement on its predecessor.

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*Figure 1: SSS and LSS for Bognor, Chichester & Littlehampton*

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I originally intended to present the extracts shown at figure 1 and to invite those with local knowledge to attempt to answer my question. However, the availability of a large-scale revision in 1910 makes it possible to present tentative answers on the basis of the County Series

**Bognor**

From the NE corner of Waterloo Square (which faces the pier) the SSS shows a brown road that leads north and then turns sharply east, emerging between St John the Baptist’s church (the one with the spire) and the station. The sharp corner mentioned is immediately adjacent to another road (white on the SSS, brown on the LSS - Crescent Road) but there is no connection. This brown road is spurious, made up by connecting narrow alleys that are probably private (fig. 2)

**Chichester**

Just outside the SE quadrant of the walls, Market Road and Market Avenue allowed traffic from Selsey to reach the Arundel road without entering the medieval city. It also gave access to the cattle market. Its brown fill on the SSS seems highly appropriate. The LSS moves this brown fill to the space between the wall and Market Avenue, so that the latter becomes white. Perhaps there was already talk of the need for a southern by-pass and the draughtsman was encouraging the creation of a dual carriageway there; but it seems more likely that this is just sloppy copying

**Littlehampton**

Here we have some genuine revision, no doubt encompassed by ‘minor corrections’: the old ferry has now been replaced by a swing bridge with a very faint ‘Toll’. The new bridge opened 27 May 1908. The changes to road fill appear to be quite independent of this. The most significant ones occur immediately north of the station. There too is the most significant error. Heading north past the station buffer stops is Albert Road. Gloucester Road goes off to the left and then one comes to a 'T' junction at Howard Road. Jink left slightly and one continues up Howard Place - still a brown road. According to the SSS one can then either turn right to reach the Arundel road or one can jink left again, continuing on what appears to be Linden Road. In fact, the large-scale plans make it clear there is no connection between Howard Place and Linden Road, whilst the link to Arundel Road is scarcely more than an alley (figure 3).

The LSS improves on this slightly by removing the brown fill from Linden Road,
but the map remains misleading in respect of the Arundel Road link.

**Overall**

The additions to the brown fill on the LSS seem to been made intelligently - certainly they are better than the SSS - but no attempt was made to correct serious errors which were prompted in the first place by thoroughly bad one-inch revision to the black plate. Even if we assume that changes to the black plate were out of the question, the SSS errors could have been mitigated by removing brown fill from spurious roads. That this was not done suggests that the draughtsmen working on the LSS had no real knowledge of the situation on the ground; they were simply guessing more perceptively than their predecessors. And at times they might introduce new errors through sloppy copying.

To examine the possibility that LSS 136 was abnormal, I also examined the overlap between SSS 287 (4.07 printing) and LSS 126 (8.14 printing). Here the only significant town, Tonbridge, showed small changes in its brown road-fill. Thus it seems likely that the practice of making LSS brown plates from scratch was general.

*Fig 3: Six-inch of Littlehampton (revised 1910) showing absence of a connection from Albert Road to Linden Road*

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*In The Eagle has Landed, shown recently on BBC-TV, German officers in 1943 are planning to capture Churchill from a house in ‘Studley Constable’, Norfolk. The map they are using (above) is evidently an even later one than the 1954 edition of Seventh Series sheet 125 (left*), as the railway is shown as dismantled.  
*reproduced by kind permission of NLS*
Evidence of a Roman map of Britain

Alan Richardson

The author is not a member of the Society, but would be interested to hear the reaction of the cartographic community to his hypothesis, which has not been published elsewhere. We asked David L. Walker to review the mathematics and geodesy involved in the article and his report follows on page 48. We invite readers to let the editor know their response.

Introduction

The modern map of Roman Britain displays a road network in which distant sites are connected by largely straight roads. In a monograph of 2003 Ferrar & Richardson argued from a platform of empirical observation and ancient texts, that this arose from the network being planned on a grid, with roads tending to connect grid-line intersections (nodes). The orientation of this putative grid was that of the Ordnance Survey (OS). The authors suggested how the Romans might have created it, but the evidence, though plausible, could not prove such a hypothesis.

This paper reports further evidence strongly suggesting the putative grid had its central datum point at the Roman site of Mediolanum, identified with Whitchurch, Shropshire. Furthermore, it was constructed according to a paradigm later described by Claudius Ptolemy (90-168 AD) but within the context of the earth’s circumference found by Eratosthenes (285-194 BC). This new evidence comprises data, OS grid-references of certain sites and the intervening distances derived from them. These data were inserted into computer spreadsheets as explained in the Appendix. For the calculations, distances were expressed in kilometres (km) and miles; the mile being the Roman mile of 5000 Roman feet of 11.65 inches.

But first we must consider the significance of the name Mediolanum.

Mediolanum

This name occurs at many places in Europe, most notably at Milan in Italy. Britain’s single example is Whitchurch. Rivet & Smith (1979, 413-417) interpreted it as “middle of the plain,” despite Whitchurch being close to low hills. They suggested the lanum element was derived from the Celtic word for a holy place; cognate with the Welsh ilan (church). They cited three other derivations; by Holder (1896-1907) who recorded 42 examples between Moesia and the Rhineland; by Flutre (1957, 39) who noted most sites were not situated on plains and who preferred “middle consecrated place” and Guyonvarc’h (1961, 142-158) who equated it with medio-nemeton, or “middle shrine”. More recently, Robb (2013) reviewed a study by Vade (2000) on its distribution in France and after visiting several sites, confirmed that most were not in the middle of plains. He suggested they were associated with ancient surveys, citing Delamarre (2003) who concluded the name was a “term of sacred geography”, a “holy centre”.

Roman land surveying

Surveying for the Romans, like all aspects of life, was a deeply religious matter (Dilke 1971, 33). Nonetheless, it is not clear why the Whitchurch Mediolanum was so named. It is not in the middle of anywhere; not even the local flat land that might have invited the formal Roman land division, limitatio, by the method known as centuriation. The Roman surveyors, agrimensores, left a considerable literature on this subject, the corpus agrimensorum romanorum preserved through the Middle Ages (Dilke 1972: Campbell, 2000). The agrimensores started their survey at a central point (tetrans), selected after taking the auspices with a holy ritual, and from it they marked out two axes (plural of
axis) at right angles; *cardo* and *decumanus*. Typically, though not invariably, these axes were aligned on the cardinal points. Upon them they set out an orthogonal grid (lines set at right angles) of boundaries (*limites*) defined by tracks or baulks. In this way they could cover large areas with square plots (*centuriae*) typically of 20 *actus*, or 2400 Roman feet. They used measuring rods, chains and the *groma*, an upright staff surmounted by two cross-arms set at right angles from which were suspended plumb-bobs. The *groma* strings were used to fix the *limites* by eye-sight and given the human eye’s stereoscopic capacity, the method was very accurate.

**Roman maps**

In contrast, we know very little of general Roman mapping. Their few known examples date from the late Empire and are not drawn to scale (Dilke 1985). There is, however, literary evidence of earlier scale maps. The emperor Augustus (63 BC-14 AD) commissioned Agrippa to make a world map that was eventually displayed in a public portico at Rome (Dilke 1985, 41-53). We know nothing of its accuracy, or of its scale, or details of its latitudes and longitudes, but almost certainly it followed the survey of the “whole world” reported by a certain Aethicus in a late document, the *Cosmographia* (Pazetti 2012). This survey was initiated by Julius Caesar about 44 BC and employed four Greeks. The text has been much criticised (Wiseman, 1992, 22-42), but there is no reason to reject the reported information about the surveyors and the time it took:

<table>
<thead>
<tr>
<th>Surveyor</th>
<th>Quarter</th>
<th>Years</th>
<th>Months</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theodotus</td>
<td>North</td>
<td>28</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Nicodemus</td>
<td>East</td>
<td>21</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Polyclitus</td>
<td>South</td>
<td>31</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Didymus</td>
<td>West</td>
<td>26</td>
<td>3</td>
<td>17</td>
</tr>
</tbody>
</table>

They are likely to have employed the methods of centuriation, but necessarily within the context of their understanding of the world, particularly latitudes, longitudes, distances and the earth’s size. The times suggest a thorough job.

**The size of the earth.**

Two centuries before the Roman invasion of Britain, the Greek scholar, Eratosthenes (275-194 BC) had calculated the earth’s circumference and obtained an amazingly accurate value. He observed that at Aswan on the Nile, at the summer solstice, the noonday sun was overhead and a vertical post cast no shadow; whilst to the north, at Alexandria, it did. He postulated the sun was so distant that its light reached all parts of the earth in parallel rays. So at the solstice at Alexandria, he measured the angle of the noonday sun to the horizon by means of a *gnomon* (sun-dial) and with some simple geometry, calculated the sector angle between the two sites. He then measured the N-S distance between them and found the distance per degree of latitude. The earth’s circumference was that value multiplied by 360. After some minor adjustments he settled for a circumference of 252,000 *stades*.

Unfortunately, there was no consistency in the length of the Greek *stade*. Diller (1948, 7-8) cited ancient sources for several values: 7.5, 8, 8.333, 9 and 10 *stades* per Roman mile, but the important point is that in the 1st century AD, the Roman intelligentsia, in the person of the scholar Pliny (AD 23-79), opted for a value that equated to 75 Roman miles per degree of latitude, believing this to be divinely inspired. This meant an earth circumference of 75 x 360 = 27,000 miles. This may be compared to

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1 One *actus* = 120 Roman feet each of 11.65 inches.
the modern value of 27,081.94 miles that gives a degree of latitude of 75.23 miles.\(^2\) In short, the 1st century Roman perception of the earth’s size, drawn from Eratosthenes, was remarkably accurate.

Not all Eratosthenes’s academic successors accepted his findings. They challenged his notion that the sun was so far away and went on to fit the reported observations on latitudes, derived by *gnomon*, to their smaller globe models. Ancient Greek geographers distrusted empirical data where it opposed their abstract theories (Cary & Warmington, 1963, 227). Thus, a century after the Roman invasion of Britain, Claudius Ptolemy of Alexandria (90-168 AD) produced a new and false earth model that misled later generations. But almost certainly those who made Agrippa’s map, and who might have surveyed Britain, would have worked to Eratosthenes’s model.

**Claudius Ptolemy’s provincial map paradigm**

It seems that the procedure for cartological surveying was similar to that of centuriation. The map-making method “recommended” by C. Ptolemy required a grid of latitudes and longitudes, rather than *limites*, to be defined over a given area and recorded on the map. But instead of marking boundaries, the surveyors probably marked the grid nodes with cairns or beacons. But this approach was not suitable over long distances because the earth’s curvature distorts the E-W scale. In the northern hemisphere, longitudes (meridians) converge as we go northwards to the pole, where they meet. That is the E-W scale shrinks whereas the N-S scale remains constant. The ancients recognised this and by applying geometry (note the meaning of the term) found that at any point of the earth’s surface there is a particular ratio of distance per degree of longitude to that of latitude. This ratio was given by the *Cosine* of the latitude (Harley and Woodward 1987, 141). Applying this to address the problem of E-W scale in the northern hemisphere, C. Ptolemy proposed a cone-like projection for the large-scale map, but when dealing with smaller areas, where E-W scale was not a big problem, he suggested, or rather reported, another solution. This was to make an orthogonal grid with parallel latitudes, but with the converging meridians straightened out and placed at closer intervals. For “prefectures and provinces,” he wrote, “... nor will it make much difference if in these maps we use parallel meridian straight lines instead of curved lines, *provided we keep the proportion of the meridian degrees marked on...*” [authors italics] (Dilke, 1985, 79: Stevenson 1932). That proportion was given by the *Cosine* of the grid’s mid-latitude. Thus, with a degree of latitude of 75 miles, the E-W distance was 75 x the *Cosine* of the mid-latitude of the province to be surveyed.

The cartological surveyors’ first step therefore was to establish the province’s mid-latitude and mid-longitude and make it the centre of their grid. The point was analogous to a *tetrans* in centuriation and given the religious nature of surveying, it would be a “central shrine”.

**Britain’s mid-latitude and longitude**

Whitchurch town (NGR 354.50 341.50 [SJ 545415]) stands at latitude 53°, half-way between the Antonine Wall (56°) and the 50th parallel that touches the tip of the Lizard peninsula. It is at the mid-latitude of an area extending from the south coast to the southern edge of the Scottish Highlands. Plausibly this was the intended Roman province and accords with Pliny’s comment (Book VI): “About thirty years ago Roman

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\(^2\) *Pears Cyclopedia* (2001), Penguin Books: earth’s radius = 6378 km: its circumference \((2\pi r) = 40079.35\) km, or 27,081.94 miles. This value divided by 360 = 75.23 Roman miles.
arms extended its knowledge no further than the area of the Caledonian forest” (Dilke 1985, 69).

But Whitchurch is far from the mid-longitude of that portion of Britain and the question arises as to how the Romans could come to make it their central grid datum. They knew Britain was roughly triangular from the dimensions reported by Caesar, Agrippa and Strabo (Dilke 1985, 47). Their starting point was probably the South Foreland of Kent, at the SE corner of the triangle, which they knew as Cantium Prom. It might be a co-incidence but it stands at latitude 51°08'. The surveyors needed to know the distance from there along the latitude to the putative mid-longitude and from thence northwards to the putative mid-latitude. But the only available data concerned the length of the south coast, from Dover to Land’s End, as given by Caesar, Agrippa and Strabo who reported distances of 500, 300 and 537-550 miles respectively (Dilke 1985, 47). The average, using Strabo’s upper figure, is 440 miles. For ease of calculation and without significant loss of credibility, it may be regarded as 450 miles.

The precise starting point cannot be known, but the South Foreland lighthouse (635.90 143.30 [TR 359430]) is a fair bet. From there they could trace a line, with groma and sun-dial, westwards to the Somerset coast. But the half-way point would not be the province’s mid-longitude because of the SW peninsula and Wales, of which they had only vague notions. But by applying geometry they could find it from the length of the south coast and the angle it made to the latitude at Cantium Prom. They were familiar with right-angled triangles; indeed, Dilke (1971, 55) cites one of their training exercises more difficult than the problem they faced here. They knew the length of the south coast but what was the angle? Between Cantium Prom and Beachy Head, the coast inclines about 30° south of the latitude, but then shifts northwards on the way to Land’s End. The extent of this shift could not be known, but Cantium Prom is at the apex of a right-angled triangle whose hypotenuse defines the mean line of the south coast, while its adjacent side lies on the latitude and its opposite side lies on a longitude (see figure 1).

When dealing with angles, the agrimensores did not work in degrees because they did not measure and describe a landscape but imposed their grid upon it. For this they defined angles in terms of trigonometric ratios expressed as whole number (integer) fractions. This enabled them to set out their limits very accurately, though it limited the choice of angles. The angle nearest to 30°, expressible as a simple fraction, is 30.96°, whose Tangent, (opposite / adjacent) is 3/5, or 0.6 in decimals. This angle occurs all over the map of Roman Britain and several road alignments are off-set by it from meridians and latitudes. They include the Fosse Way: Stane Street, Sussex: King Street, Cheshire, and Ribchester-Slaiburn, Lancs. (Ferrar & Richardson 2003, 4-5). It also

![Figure 1: Suggested Roman perception of the south coast of Britain in AD 43.](image-url)
defines some alignments of other Roman roads (Richardson, unpublished). At Florence, it was applied to off-set the centuriation from the city's east-west axis (Hardie 1965). This would have been done by measuring three units W along the cardo and then five units N and then joining the two ends. Hence the south coast's inclination from the latitude would be regarded as the ratio 3/5.

Now by Pythagoras's theorem, the hypotenuse of the 3:5 triangle is 5.83 (sq. root 3² + 5²). This is not a convenient measure in actus, but converting to feet it gives a triangle 360:600:700; which is convenient for setting-out (Ferrar, personal communication). These proportions could be expressed 36:60:70; or even 3.6:6.7. So, from half the length of the south coast (450 / 2 = 225 miles) they could find the distance from Cantium Prom along its latitude towards the mid-longitude, the line CP-L in figure 1. Dividing 225 by 7 and then multiplying by 6 gives 193 miles, or 285.6 km. This distance west of Cantium Prom reaches 350.30E, an easting that runs 3.5 km W of Whitchurch town.

Having traced this line 193 miles westward to 350.30E, they could place a beacon and then measure northwards along the meridian to the mid-latitude. That point would be at the half-way point of the province's N-S dimension. We do not know what figure they had in mind, but 350.30E passes 3.5 km W of Whitchurch, very close to a tumulus of unknown provenance, Warren Tump in Flintshire, (349.96 342.10 [S] 500421). This tumulus stands on latitude 53° and plausibly could be the site of the Mediolanum. Now if the hypothesis posited here be correct, the distance from that place to the south coast would be half the N-S dimension of the intended province. From Warren Tump to the Cantium Prom latitude is 134.33 miles. To this we must add the distance to the south coast defined by the opposite side of the triangle in figure 1. So, (225 / 7) x 3.6 = 115.8 miles; and 115.8 + 134.33 gives a distance from the coast to Mediolanum of 250.1 miles. This is an astonishingly plausible figure. It implies the surveyors presumed the island, or the portion of it that interested them, was 500 miles north to south.

The fact that the latitude of the South Foreland is at 51° and Warren Tump is at 53° might be coincidence. It might also be a coincidence that the Cosine of 53° is 0.6, or 3/5, which means that any Ptolemy-like grid centred on Warren Tump would have latitudes at 75-mile intervals and longitudes at 45-mile intervals (75 x 0.6 = 45). If such a grid were used to plan the infrastructure, we might expect the dispositions of major Roman major sites to disclose those dimensions.

The frontier walls

Consider the Hadrianic and Antonine Walls. They follow very closely latitudes 55° and 56° respectively. Table 1 lists the OS grid references of their forts.

| Table 1: OS Grid References of Roman Wall forts [References are in km from the OS grid origin.] |
|---------------------------------------------|---------------------------------------------|
| Old Kilpatrick                              | 246.00                                      |
| Duntocher                                   | 249.52                                      |
| Castle Hill                                 | 252.45                                      |
| New Kilpatrick                              | 254.56                                      |
| Bowness                                     | 673.10                                      |
| Drumsburg                                   | 672.63                                      |
| Burgh by Sands                              | 672.63                                      |
| Stanwix                                     | 672.08                                      |
| Hadrian’s Wall                              | 322.25                                      |
|                                             | 562.68                                      |
|                                             | 326.50                                      |
|                                             | 559.83                                      |
|                                             | 333.83                                      |
|                                             | 559.15                                      |
|                                             | 340.22                                      |
|                                             | 557.14                                      |

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3 635.90 – 285.60 = 350.30
4 The discrepancy between true N and OS grid N at this longitude is insignificant.
5 Flintshire Sites and Monuments Records.
6 OS value = 52°58’.
7 342.10 – 143.30 = 198.8 km = 134.33 miles.
8 Read from the OS map. Hadrian’s Wall sites were checked by GPS.
Balmuidy  258.11  671.70  Castlesteads  351.70  563.46
Cadder  261.68  672.55  Birdoswald  361.56  566.28
Kirkintilloch  265.20  673.96  Cavoran  366.53  565.72
Auchendavy  267.73  674.93  Gt Chesters  370.37  566.78
Bar Hill  270.73  675.90  Housesteads  378.96  568.81
Croy Hill  273.35  676.53  Carrawbrough  385.90  571.18
Westermoord  276.08  677.23  Chester's  391.17  570.17
Castlecary  278.95  678.25  Halton Chester’s  399.72  568.47
Seabegs  281.83  679.53  Benwell  421.56  564.78
Rough Castle  284.35  679.85  Newcastle  425.07  563.84
Camelon  286.35  680.95  Falkirk  430.06  566.06
Munrills  291.85  679.31
Inveravon  295.15  679.56
Kinniel  298.30  680.50
Bridgeness  301.30  681.35
Carnden  302.60  680.75
Medians  276.08  677.23  374.67  565.89
Range (km)  56.60  9.65  107.81  9.12

Northings: The median values are those in the middle of each range; Westerwood on the Antonine Wall and Carvoran on Hadrian’s Wall. Both stand on the integer latitudes, not just nearby, and the difference between them is 111.34 km; 75.23 miles or 1° latitude.\(^9\) Table 1 shows the actual latitudinal range of the other forts: 9.65 km (Antonine Wall) and 9.12 km (Hadrian’s Wall).

Eastings: Westerwood fort, in the median position on the Antonine Wall, was the medio-nemeton mentioned in the Ravenna Cosmography (MacDonald, 1934, 189). Like Mediolanum, the name is Latinised Celtic meaning “middle grove” or “middle shrine” (Rivet & Smith, 1979, 416–417). The EW distance between the fort and Warren Tump is 71.88 km, or 48.57 miles.\(^10\) This is not quite the 1° longitude (45 miles) of Ptolemy’s paradigm but the relationship between fort and shrine was probably similar to that of the Roman settlement at Whitchurch which was some three miles east of Warren Tump; the shrines giving their names to the neighbouring sites.\(^11\) The land east of Westerwood fort is covered by modern development so any possible shrine will have been lost. It cannot be proved, but it is highly likely, that the two shrines were separated by 45 miles and so henceforth in this paper, all quoted longitudes will be at 45-mile intervals from Warren Tump. Latitudes, at 75-mile intervals, coincide with modern values. Both these dimensions are divisible by 15, which is consistent with an orthogonal grid of 15-mile intervals.

Latitudes: The mean latitudes of the Walls are 3.02° (Antonine) and 2.02° (Hadrianic) (see table 2). The second decimal place equates to 0.75 miles for the latitudes and 0.45 miles for longitudes. Considering the forts are 150 and 225 miles from Warren Tump, the variation about the integer latitudes is very small; 0.02° with both walls.

---
\(^9\) 677.23 - 565.89 = 111.34.
\(^10\) 349.96 – 278.08 = 71.88 km = 48.57 miles.
\(^11\) Less than a mile due south of Westerwood fort, on a hill top by a modern trig point, stands a Roman altar, the Carrickstone, possibly a surveyors’ beacon.
Table 2: Latitudinal distances from Warren Tump to the frontier wall forts.

<table>
<thead>
<tr>
<th>Forts (Antonine)</th>
<th>Miles</th>
<th>Degrees</th>
<th>Forts (Hadrianic)</th>
<th>Miles</th>
<th>Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Kilpatrick</td>
<td>223.7</td>
<td>2.98</td>
<td>Bowness</td>
<td>151.5</td>
<td>2.02</td>
</tr>
<tr>
<td>Duntocher</td>
<td>223.3</td>
<td>2.98</td>
<td>Drumburgh</td>
<td>149.0</td>
<td>1.99</td>
</tr>
<tr>
<td>Castle Hill</td>
<td>223.3</td>
<td>2.98</td>
<td>Burgh by Sands</td>
<td>151.1</td>
<td>2.01</td>
</tr>
<tr>
<td>New Kilpatrick</td>
<td>223.0</td>
<td>2.97</td>
<td>Stanwix</td>
<td>151.3</td>
<td>2.02</td>
</tr>
<tr>
<td>Balnuidy</td>
<td>222.7</td>
<td>2.97</td>
<td>Castlesteads</td>
<td>149.6</td>
<td>1.99</td>
</tr>
<tr>
<td>Cadder</td>
<td>223.3</td>
<td>2.98</td>
<td>Birdsoswald</td>
<td>147.1</td>
<td>1.96</td>
</tr>
<tr>
<td>Kirkintilloch</td>
<td>224.2</td>
<td>2.99</td>
<td>Carvoran</td>
<td>146.7</td>
<td>1.96</td>
</tr>
<tr>
<td>Auchendavy</td>
<td>224.9</td>
<td>3.00</td>
<td>Gt Chesters</td>
<td>149.8</td>
<td>2.00</td>
</tr>
<tr>
<td>Bar Hill</td>
<td>225.6</td>
<td>3.01</td>
<td>Housesteads</td>
<td>145.3</td>
<td>1.94</td>
</tr>
<tr>
<td>Croy Hill</td>
<td>226.0</td>
<td>3.01</td>
<td>Carrawborough</td>
<td>150.5</td>
<td>2.01</td>
</tr>
<tr>
<td>Westerwood</td>
<td>226.5</td>
<td>3.02</td>
<td>Chertes</td>
<td>152.3</td>
<td>2.03</td>
</tr>
<tr>
<td>Castle Cary</td>
<td>227.1</td>
<td>3.03</td>
<td>Halton Chesters</td>
<td>153.0</td>
<td>2.04</td>
</tr>
<tr>
<td>Seabegs</td>
<td>228.0</td>
<td>3.04</td>
<td>Rudchester</td>
<td>154.1</td>
<td>2.05</td>
</tr>
<tr>
<td>Rough Castle</td>
<td>228.2</td>
<td>3.04</td>
<td>Benwell</td>
<td>155.2</td>
<td>2.07</td>
</tr>
<tr>
<td>Camelon</td>
<td>229.0</td>
<td>3.05</td>
<td>Newcastle</td>
<td>153.2</td>
<td>2.04</td>
</tr>
<tr>
<td>Falkirk</td>
<td>228.3</td>
<td>3.04</td>
<td>Wallsend</td>
<td>151.8</td>
<td>2.02</td>
</tr>
<tr>
<td>Mumrils</td>
<td>227.9</td>
<td>3.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inveravon</td>
<td>228.0</td>
<td>3.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinniel</td>
<td>228.7</td>
<td>3.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridgness</td>
<td>229.2</td>
<td>3.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carriden</td>
<td>228.8</td>
<td>3.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medians</td>
<td>226.5</td>
<td>3.0</td>
<td></td>
<td>150.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**The Fosse Way**

The Fosse Way’s mean course between Axminster and Lincoln is a straight line. Its northern terminus at Lincoln is 99.7 (100) miles east and 20.0 miles north of Warren Tump. Due south of Warren Tump, there is a hamlet at Durnfield (349.50 120.40 [ST 495204]) just south of Ilchester town, which stands on latitude 51°N. The distance is 149.40 (150) miles.\(^\text{12}\) So the inclination (tangent) of the Fosse Way to the meridian is \((100 / (150 + 20) = 0.6, or 3/5.\(^\text{13}\)

Figure 2 shows these dispositions in relation to the mid-longitude (WS) and the Cantium Prom parallel (CB). The NS distance from Warren Tump to the south coast (WS) is 250 miles (see above) and comprises three sections; WB, BD and DS.

WB, the NS distance from Warren Tump to parallel CB is 134.3 miles (see above).

BD, the NS distance from parallel CB to Durnfield is 15.47 miles, virtually one interval on the putative 15-mile grid.\(^\text{14}\)

DS, the NS distance from Durnfield to the coast, is BS – BD or 100.23 miles.\(^\text{15}\)

\(^{12}\) 341.50 − 120.40 = 221.66 km = 149.40 miles.

\(^{13}\) The same as that obtained with a statistical method by Ferrar & Richardson (2003, 3).

\(^{14}\) 143.30N − 120.40N = 22.9 km = 15.47 miles.

\(^{15}\) 115.7 − 15.47 = 100.23 miles.
The distance from Mediolanum to Durnfield, 150 miles, is a simple multiple of 15 miles (10 x 15). The likely explanation is that after establishing Mediolanum, the surveyors recalibrated the mid-longitude southwards in 15-mile units. After ten, they marked the original datum for Fosse Way which was then off-set by \( \tan 3/5 \) from the mid-longitude. It inclined roughly NNW north of Durnfield and roughly SSW south of that point. In setting out the road’s design line, 7 units along its course would tie-in with 6 units along the mid-longitude. See above. That unit could have been the actus of 120 feet, for which the surveyors had the agrimensores’ standard chain. The Fosse Way broadly follows the limestone ridge which was probably already open country affording long views. The road did not connect Axminster to Lincoln; those sites were planted at each end after it was made.

**Ratios**

Westerwood stands 3° N and 1° W of Warren Tump, a ratio 3:1. Similarly, Lincoln is 99.7 (100) miles east and 20.0 miles north; a ratio of 5:1. Such relationships may be coincidence or an unintended consequence of planning with a grid, but they may also be due to the reverence for numerical ratios, probably derived from the Pythagoreans, that permeated all aspects of Roman military organisation. Ratios governed pay scales (Breeze & Dobson 2000, 183-184), the aspect ratios of camps and forts and the army’s order of battle (Richardson, 2004). Hence, we might expect to find more in the dispositions of military sites.

**Legionary fortresses**

Table 3 shows how nine legionary fortresses relate to Warren Tump. Most distances, in degrees, are close to integer values, or are simple fractions thereof. Besides Lincoln relating to Warren Tump by a ratio of 1:5, York relates by 75 miles north and 75 miles east; a ratio of 1:1 and distances of 5 x 15 miles. In degrees, the ratio is 1:166, and converted to thirds of a degree, it is the familiar 3:5. This strikes us as utterly abstruse, but that was not how Pliny would have seen it. Gloucester is just over 1° S and 0.5° W, or 2:1. The ratio to nearby Wroxeter is 0.3° S, to 0.1° E, or 3:1. Chester’s ratio is 0.14 W: 0.21 N; or 2:3. The likely explanation is that, wherever possible, a site was made to stand in a definable spatial relationship to some other divinely approved location. The grid would therefore be a necessary element in the augury that preceded every major military decision from pitching camp to going into battle. But geometric considerations would not overrule practical considerations, merely reveal divine approval.

<table>
<thead>
<tr>
<th>Fortress</th>
<th>eastings</th>
<th>northings</th>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>miles</td>
<td>degrees</td>
<td>miles</td>
<td>degrees</td>
</tr>
<tr>
<td>Caerleon</td>
<td>333.90</td>
<td>190.60</td>
<td>11</td>
<td>0.24</td>
</tr>
<tr>
<td>Chester</td>
<td>340.65</td>
<td>365.10</td>
<td>6</td>
<td>0.14</td>
</tr>
<tr>
<td>York</td>
<td>460.65</td>
<td>452.20</td>
<td>-75</td>
<td>-1.66</td>
</tr>
<tr>
<td>Inchtuthil</td>
<td>312.50</td>
<td>739.50</td>
<td>25</td>
<td>0.56</td>
</tr>
<tr>
<td>Exeter</td>
<td>292.30</td>
<td>92.50</td>
<td>39</td>
<td>0.87</td>
</tr>
<tr>
<td>Gloucester</td>
<td>383.20</td>
<td>218.90</td>
<td>-22</td>
<td>-0.50</td>
</tr>
<tr>
<td>Colchester</td>
<td>599.90</td>
<td>225.30</td>
<td>-169</td>
<td>-3.75</td>
</tr>
<tr>
<td>Wroxeter</td>
<td>356.50</td>
<td>308.50</td>
<td>-4</td>
<td>-0.10</td>
</tr>
<tr>
<td>Lincoln</td>
<td>497.50</td>
<td>371.50</td>
<td>-100</td>
<td>-2.22</td>
</tr>
</tbody>
</table>

**Table 3: Legionary fortresses in relation to Warren Tump**

Negative values are east and south.
**Forts**

Some forts in NW England, excluding Hadrian’s Wall forts, seem to relate similarly to Warren Tump. Six lying on two lines of latitude and seven on two lines of longitude illustrate this.

**Latitudes:** The four forts at 2° N on the Stanegate, an early frontier, seem to have been carefully placed. The average latitude of Bowes, Brough and Ambleside is 1.52° N, the 0.02° represents a 1.5 mile variation over a distance of 41.9 miles. See table 4.

<table>
<thead>
<tr>
<th>Fort</th>
<th>eastings</th>
<th>northing</th>
<th>degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throp</td>
<td>363.12</td>
<td>565.93</td>
<td>2.02</td>
</tr>
<tr>
<td>Nether Denton</td>
<td>359.56</td>
<td>564.64</td>
<td>2.00</td>
</tr>
<tr>
<td>Castle Hill</td>
<td>354.43</td>
<td>563.00</td>
<td>1.99</td>
</tr>
<tr>
<td>Old Church Brampton</td>
<td>350.96</td>
<td>561.50</td>
<td>1.98</td>
</tr>
<tr>
<td>Brough</td>
<td>379.15</td>
<td>514.00</td>
<td>1.55</td>
</tr>
<tr>
<td>Bowes</td>
<td>399.25</td>
<td>513.35</td>
<td>1.54</td>
</tr>
<tr>
<td>Ambleside</td>
<td>337.22</td>
<td>503.45</td>
<td>1.45</td>
</tr>
<tr>
<td>mean</td>
<td></td>
<td></td>
<td>1.52</td>
</tr>
</tbody>
</table>

**Longitude:** The average longitude of Old Church Brampton, Old Penrith, Watercrook and Lancaster is 0.003° E. This is within 675 feet of the integer longitude 0° over a distance of 67.2 miles. This is unlikely to be coincidence, no more than is Old Church Brampton’s situation at 2° N and 0°. The data for Manchester, Chesterton and Gloucester are more eloquent; all are on easting 383.2, or 0.499° west of Warren Tump. Note the value to the third decimal place which is 225 feet over a NS distance of 120 (8 x15) miles. (See table 5).

<table>
<thead>
<tr>
<th>Fort</th>
<th>eastings</th>
<th>miles</th>
<th>longitude</th>
<th>15-mile grid line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Ch. Brampton</td>
<td>350.96</td>
<td>-0.7</td>
<td>-0.02</td>
<td>-0.05</td>
</tr>
<tr>
<td>Old Penrith</td>
<td>349.30</td>
<td>0.4</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Watercrook</td>
<td>351.45</td>
<td>-1.0</td>
<td>-0.02</td>
<td>-0.07</td>
</tr>
<tr>
<td>Lancaster</td>
<td>347.30</td>
<td>1.8</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>means</td>
<td>349.75</td>
<td>0.1</td>
<td>0.003</td>
<td>0.01</td>
</tr>
<tr>
<td>Manchester</td>
<td>383.18</td>
<td>-22.4</td>
<td>-0.50</td>
<td>-1.50</td>
</tr>
<tr>
<td>Chesterton</td>
<td>383.20</td>
<td>-22.5</td>
<td>-0.50</td>
<td>-1.50</td>
</tr>
<tr>
<td>Gloucester</td>
<td>383.20</td>
<td>-22.5</td>
<td>-0.50</td>
<td>-1.50</td>
</tr>
<tr>
<td>means</td>
<td>383.19</td>
<td>-22.5</td>
<td>-0.50</td>
<td>-1.50</td>
</tr>
</tbody>
</table>

**Pairs of forts:** Eighteen forts in NW England taken from a sample of 49 share a latitude with another. These are small numbers and it would be unwise to draw conclusions, but it seems unlikely to be coincidence. On the other hand, if one were to tip a handful of peas onto a chessboard, some peas would be bound to share columns and rows. If a few peas were tossed, there would be fewer such occurrences. The question of whether forts tend to line up along particular parallels and meridians requires more data and the attention of a statistician. Nevertheless, Table 6 shows three interesting pairs.

---

16 75 x .02 = 1.5 miles.
17 45 x 0.001 x 5000 = 225.
18 Manchester northing = 397.62; Gloucester northing = 218.9. The difference is 178.72 km.
Hardknott and Low Borrow Bridge, 34.2 miles apart E-W, are only 0.1 miles (500 feet) apart N-S. Over a smaller distance (7 miles), Papcastle and Burrow Walls are separated by a similarly small N-S distance. Watercrook and Bainbridge, separated by 28.6 miles E-W, are 0.47 miles (1850 feet) apart from north to south. (See table 6.)

<table>
<thead>
<tr>
<th>Fort</th>
<th>OS grid refs.</th>
<th>From Warren Tump</th>
<th>Differences between forts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Hardknott</td>
<td>321.80</td>
<td>501.50</td>
<td>107.71</td>
</tr>
<tr>
<td>Low Borrow Bridge</td>
<td>356.00</td>
<td>501.35</td>
<td>107.61</td>
</tr>
<tr>
<td>Watercrook</td>
<td>351.45</td>
<td>490.70</td>
<td>100.41</td>
</tr>
<tr>
<td>Bainbridge</td>
<td>393.75</td>
<td>490.15</td>
<td>100.04</td>
</tr>
<tr>
<td>Papcastle</td>
<td>310.80</td>
<td>531.60</td>
<td>128.05</td>
</tr>
<tr>
<td>Burrow Walls</td>
<td>309.50</td>
<td>530.20</td>
<td>127.10</td>
</tr>
<tr>
<td>mean</td>
<td></td>
<td></td>
<td>0.47</td>
</tr>
</tbody>
</table>

**Watling Street**

The putative Roman grid of 15-mile squares could explain a long-standing puzzle. Why does the Watling Street, connecting London to the north-west Midlands, not issue directly from one of London’s gates but instead begins by a branch at Marble Arch from the Roman road running westwards? The EW distance between Warren Tump and Marble Arch (527.75E) is 120 miles (8 x 15).¹⁹ The inference is that the southern terminus of Watling Street was defined from the map grid without immediate reference to Roman London. It may originally have continued across the Thames to join the Watling Street of Kent.

The most northerly stretch of Watling Street from a terminus north-west of Wroxeter that was almost certainly due south of Warren Tump, follows closely northing 309.00 for most of way eastwards to Wall (OS 410.20 306.50). The mean northing of the longest straight section (North Telford to Wall) is 309.07 which is 21.0 miles south of Warren Tump.²⁰ This is 1.5 miles short of 1.5 15-mile units and that parallel was almost certainly the road’s design line. Marble Arch’s northing is 181.00, so the NS distance between it and Warren Tump is 109 miles.²¹ 110 miles would make it 7.33 15-mile units. Thus from the Watling Street north of Wroxeter to Marble Arch is 7.33 – 1.5 = 5.83 units. This is √34, the hypotenuse of the familiar right-angled triangle with the other sides in the ratio 3:5; in this case 45 and 75 miles. This is good evidence that Watling Street was planned on a grid aligned $\tan 3/5$ west of north, as suspected by Michael Ferrar (Ferrar & Richardson 2003 28). This is discernible on the map south of the road’s inter-section with the Fosse Way at High Cross.

**The Roman map of Germany**

The general thesis advanced in this paper is supported by recent German studies. Kleinberg, Marx & Lelgemann (2012) have reprocessed data from C. Ptolemy’s *Germania*, combining geodesy, philology and classical literature to produce a far more plausible map. They concluded the Roman army had surveyed accurately the land

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¹⁹ $527.75 - 349.96 = 177.79 \text{ km} = 120.13 \text{ miles}.$

²⁰ $340.10 - 309.07 = 31.03 \text{ km} = 20.96 \text{ miles}.$

²¹ $342.10 - 181.00 = 161.10 \text{ km} = 108.9 \text{ miles}.$
between the Rhine and the Vistula and C. Ptolemy had used their maps. Tupikova (2014) found that Ptolemy's data transposed onto the earth model of Eratosthenes "greatly improves the positions of the locations given in Ptolemy’s catalogue..." Thus the Roman surveyors of Germany almost certainly made maps based on Eratosthenes's earth model using methods available to those in the British invasion force.

Discussion
The data for this study were OS grid references of certain sites and the intervening distances found by spreadsheet. The spatial relationships between Warren Tump and the several Roman military sites are surely not accidental. It is not suggested, however, that these dispositions would have defied military and political imperatives; rather that they would have been seen as divinely harmonious with them. We should not underrate the power of ancient superstition to influence decisions, for even on the battlefield tactical opportunities were often shunned because of unfavourable omens.

If the several observations described above are not a set of amazing coincidences, the hypothesis proposed is the only likely explanation. That is, after arriving in Britain, the Romans began surveying by the paradigm later explained, and prescribed, by C. Ptolemy, but within the context of Eratosthenes's earth model. They first sought the province’s mid-latitude and mid-longitude, believing the south coast to be 450 miles long and inclined \( \text{Atan} \ 3/5 \ S \) of \( \text{W} \); and that their province’s longitudinal dimension would be 500 miles. They established their \text{mediolamum} with astonishing accuracy and then set out an orthogonal grid upon which to plan the infrastructure. This grid with its 15-mile intervals fitted neatly with the intervals of latitudes and longitudes and must have remained extant until at least the advent of the Antonine Wall (c.140 AD). Warren Tump may prove to be a prehistoric feature or a Norman rabbit warren, but that would not preclude its being a Roman survey point.

If all this be true, its significance is considerable. Without accounting for the feat of the four Greeks of Aethicus, the survey proposed here was an astonishing achievement. As the late Robin Birley once said in a lecture at Vindolanda, “We constantly underestimate these people.” We do indeed. The early history of Roman Britain will have to be revisited.

Appendix
The spreadsheet is made to find the differences between a site’s eastings and northings from those of the reference point. These differences, expressed as km, are converted to Roman miles. To do this, first convert km to inches (km x 1000 x 39.36); then divide by 11.65, and again by 5000. To convert miles to km, reverse the process. \([\text{miles} \times 5000 \times 11.65] / 39.36\) divided by 1000. Where required, The N-S distances are converted to degrees by dividing by 75 and the E-W distances by 45.

Acknowledgements
The author wishes to thank those who in the past have provided useful advice, the late Prof Oswald Dilke, Mr Michael Ferrar, Prof R.A. Brown of New York and Dr Stephen Walker.

References
5. OAW Dilke, 1985: *Greek and Roman Maps*, Thames and Hudson.
18. ALF Rivet & Colin Smith, 1979: Place-Names of Roman Britain, Batsford.

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Reviewing the evidence

David L Walker

In response to the editor’s invitation, this reviewer started with a readiness to be convinced of Alan Richardson’s radical hypothesis that Roman sites were chosen by reference to a rectangular grid referred to degrees of longitude and latitude. Having experienced the accuracy of visual observations using a couple of plumb lines, he has tried to react positively to the author’s thorough research into Roman surveying rather than picking holes in the details.

The basis of the paper is verifiable, that Pliny in the first century AD adopted 75 Roman miles per degree of latitude, and that this nearly corresponds with present day measurements. At Mediolanum (the supposed origin of the Roman grid, sited in Whitchurch), a degree of longitude does measure about 45 Roman miles, and OS grid north, adopted for the author’s calculations, is not very different from true north.

It is at least a happy coincidence that the Roman site of Mediolanum, thought to be a ‘term of sacred geography’ meaning ‘middle place’ or ‘holy centre’, lies with 5 seconds of the meridian of Delamere Forest (and less than 20 minutes south). Delamere Forest, almost a ‘term of sacred geography’ to some of us, was adopted for the best part of a century as the origin of the one-inch maps of England and Wales (and some of Scotland). This makes Mediolanum appealing as an origin, especially as its meaning is attributed to one Xavier Delamarr, although it is disappointing that the author then moves the Roman origin to Warren Tump, 3.5 km west of Whitchurch.

However, as an impediment to the Scots, the Solway Firth and the Whin Sill escarpment appear to explain the line of Hadrian’s Wall better than the latitude of Warren Tump. Similarly, the Firth of Clyde appears to explain the less spectacular line of the Antonine Wall (although the author might argue that these walls could have followed shorter routes from coast to coast if their latitudes were unimportant).

Nine legionary fortresses are identified at distances close to integer values of degrees, or simple fractions thereof, measured north/south and east/west of Warren Tump, but a sceptic could suggest that most of these fortresses were sited to protect strategic river crossings.

From the large number of Roman forts, groups of two, three or four are shown to be close to the same latitude, but a statistician might point out, by way of comparison, that in any group of 30 people there is a 70% probability that two will share the same birthday.

These arguments unfortunately left this reviewer unconvinced that Roman surveyors found it necessary or feasible to establish an orthogonal grid across Britain to locate their infrastructure. However, as a hypothesis like this is difficult to prove or disprove, he supports the editor’s decision to invite other readers to consider this bold proposition.

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1 on page 36 of this edition of Sheetlines.
**Kerry musing**

*David Archer*

Between 1986 and 2008, we issued 54 catalogues of Ordnance Survey maps, and whilst taking calls for the first catalogue I offered to record any sold or not listed item as a ‘want’, and would let people know when a copy was available. Wants lists worked very well both for us and for our customers, but they did involve more work and keeping quite detailed records. By the third catalogue we realised that if we were to make a success of our business, a telephone call should result in a sale rather than a recorded ‘want’. At which point we decided to buy everything that came our way, and wherever possible, to stock the full range of Ordnance Survey maps, no matter how unlikely they might be to sell. Every customer had different requirements, early or late states of a sheet, this or that cover, top quality or a cheap scruffy map. We therefore needed lots of maps in order to offer a wide choice and intentionally built a stock that included a large number of duplicates. If someone wanted a particular sheet in a certain cover and condition, or around a particular date and we did not have it, we could hopefully offer a close alternative, which was usually taken.

Having such a large stock had its disadvantages, as we were easily distracted by a customer’s search for something, or our own self-inflicted distractions, any of which could take a lot of time, albeit enjoyable time. If a customer wanted a map to show a given feature at a certain date, we could usually pull out both the required state and the one before, showing the feature absent. We had good fun following a trail, and frequently sold both maps. For my own interests, this often resulted in partial research on a topic, which was interrupted by a second diversion, leaving the first unfinished. A butterfly mind indeed.

I can remember looking at the *Snowdon District* relief style map, 1925 (6038, published 1938), where, in square C7, sitting off-shore, the words ‘Road Tunnel’ are in a wonderful bright orangy-red italic lettering which always catches the eye. So unlike any other colour used by the OS and totally distracting from the subtle colours used for the rest of the map. It should never have been allowed and is fantastic. Scanning the north coast of Wales the eye always stops at these two words, ‘Road Tunnel’, and is then attracted by the red roads of the same colour, which pulsate, giving a 3D effect and look as if they have been neatly added by hand. An armchair hill walker gets nowhere other than following the road from Conway (Conwy) to Bettws-y-Coed, and is immediately distracted by the roads going west from Capel Curig with no consideration for the superb depiction of the mountains hereabouts. However, this seems only to work in the context of the relief style, as what appears to be the same colour is used on my copy of Fifth Relief Sheet 131, *Salisbury and Winchester* (5038, published 1938) where the red roads are far too prominent and look like a child’s scribbling with a thin lipstick, distracting the eye from any other feature. But the level crossings and station symbol in-fills are spot on and give the same pleasure as the bright reds in the *Dandy* and *Beano* of old.

The *Snowdon District* set me off on yet another diversion from earning a
living. What other maps used this unusual red I wondered? And for no particular reason, I began by going through the quarter-inch Third Edition maps, starting with England and Wales Sheet 3, 1921, where I noticed that the road between Sedbury Hall (Scotch Corner) and Gilmonby on most printings had been coloured red, by hand. Well executed, but not too difficult to spot as the colour is not quite right. Ploughing through more copies of sheet 3, on the later 6000/29 printing, the road from Scotch Corner was now printed red with a road number, but two new red roads, the A1085 and A1042 at Redcar stood out as they both lacked black road casings.\(^1\) Thus, I was immediately diverted from shades of road colours to shall we say ‘problems’ with road colouring and numbering, and having been alerted, I began searching for more examples on quarter-inch maps, which came readily enough. On England and Wales Sheet 6A, 7500/30, I was undecided whether the road going south east from Barrow upon Humber in square B10 to Brocklesby was hand coloured, but a red road number was lacking. Square B10 also produced a red ‘A1204’ at Bonby, square C9 a red ‘B1400’ at Cleatham and a red ‘B1207’ at Sturton, all placed beside uncoloured roads. Oh, the time I wasted on this. Wasted?

So, after two sheets, I had red roads lacking black casings; a hand coloured red road, with another possible hand coloured road lacking a number; plus red road numbers lacking road colouring. Interesting, I thought.

Turning to sheet 1, which in all its printings was common to both the England and Wales and Scotland sets, new sightings appeared along familiar lines. At the top of the 2000/33 printing, north of Duns, is a red ‘A6112’, alongside an uncoloured road, whilst the same road from Coldstream north to Swinton has been treated similarly. Again, on the first state of this printing, to the east of Dalbeattie the A745 and quite a long stretch of the A710 are shown uncoloured with red road numbers. But even if the red road numbers are all over the map, they are lacking from the legend, just a black ‘or’ is shown, rather than ‘A71 or B730’ above a red road. And to muddy waters further, the earlier 5800/30 did have red road numbers in the legend. Two copies of a second state of the 2000/33 printing then appeared, both with slightly smudged hand coloured roads around Duns, Coldstream and Dalbeattie, but the corrected legend appears not to have been done by hand. Even more interesting.

Knowing what I was looking for, other Scottish examples appeared thick and fast. On Scotland Sheets 2, 4, 5, 6 and 7 I found examples of red road numbers beside uncoloured roads. As originally issued sheet 2, 2000/32, has Arran without any red, but a later state of 2000/32 has red roads and road numbers hand coloured; whilst both states have a red road number and arrow pointing to an uncoloured road west of Campbeltown, indicating only a partial correction of the first state. I did not find any altered copies of sheets 4, 5, 6 or 7 and told Chris Board of my findings in late 1997. Whilst looking for something else, Chris found a file at the Public Record Office, as was, that noted Scotland Sheets 1, 2 and 3

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\(^1\) The Danby Wiske station symbol, open 1884 to 1958, was now uncoloured, but I ignored this new distraction.
were to be corrected, or whatever the term used, by hand, 50 copies of each to be done, with sheet 1 already finished. Scotland Sheets 4, 5, 6 and 7 were to be reprinted. Alas, neither of us followed this up.

It was certainly a wise decision to reprint, rather than correct sheet 4, as Colonsay has two red road numbers placed across the road casings and could not have been corrected by hand. Expediency also reigned during the hand colouring exercises, as a quick bit of road revision was undertaken on sheet 1, where a slightly smudged red road lacking a number was added going north from Kirkoswold to Craglin, in square J6, whilst to the west of Nether Howecleuch in square D2, a quite noticeable road re-alignment was added to the existing road, making for a very confusing road layout. A mini Spaghetti Junction.

Fast forward from the early to the late nineteen thirties and another occasion where such shenanigans went on. If you are able to, open a copy of the one-inch Southampton District map of 1928, and look at square E7. If the road running east-west from Portswood to Bitterne is red, it is hand coloured over the original orange. Very well executed, with a slight colour difference. If your copy has the original orange road, lucky you.

That the OS decided on manual corrections to Southampton District and only fifty copies each of the three quarter-inch sheets might show how few were sold, or could be corrected easily, ruling out a reprint. But why were Scotland Sheets 5, 6 and 7 reprinted, especially when sheet 7 could have easily been corrected by hand? Hand colouring was all done on the quiet, with no acknowledgement, whereas the OS could have taken the lead from a producer of Melton Mowbray pork pies and have advertised the maps as being a superior hand-finished product.

As I say, all this was about twenty years ago, and today, I only have a handful of quarter-inch maps and minimal notes, so would find it difficult to continue my investigations, which were quickly superseded by some other three-day wonder, and I am left wondering whether the OS did in fact hand colour 50 copies of Scotland Sheet 3, what were the problems thus corrected, and what might one find elsewhere with a bit of study? Please let me know.

Alas, I am now in the same position as a lot of our members who have spotted something that needs investigation: where does one get easy access to multiple copies of the same sheet? It used to be easy for me, as we stocked ten, twelve or maybe fifteen copies of some sheets, but would now find it too complicated to track down five copies of the same map. Perhaps the answer lies in crowd research amongst our members. If I set out what my study entails and

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2 This piece is based on the following states of each sheet: Scotland Sheet 1 2000/33, Sheet 2 2000/32, Sheet 4 2500/33, Sheet 5 2450/34, Sheet 6 2000/33, Sheet 7 2000/33. I have no copy of sheet 3. I understand from Roger Hellyer that all are final printings of each sheet. Does anyone have sheets 4, 5, 6 and 7 with these print codes or later, and roads coloured as required, or lacking road numbers, e.g. Sheet 4 square F4, Sheet 5 D9, Sheet 6 A2 and Sheet 7 D10?

3 Has any member evidence of other colours having been applied to standard series maps by hand?
what information I want, perhaps details could appear in Sheetlines, on the society website or ordnancemaps, and members could notify anything they found. On-going research, which anyone can add to, a bit like the half-inch meeting that Guy Messenger organised at Uppingham all those years ago. An even better whizz than having members spend hours inspecting maps for very small differences, would be if we could get access to something members saw on a visit to the Ministry of Defence at Hermitage in 1997. We were shown a piece of kit, as the military call anything from a tank to a teaspoon, which superimposed a satellite image on a map of the same area and checked for any differences. If this could be done for two supposedly identical maps, an awful lot of discoveries would be made without all the eye strain.

In a way the OS were lucky, as it would have been far harder to remove detail by hand if a reprint was ruled out. On England and Wales half-inch Sheet 38, Southampton, 1906 we find a label: The road from CHALE along the coast to FRESHWATER is not now in good repair and should not be coloured as 2nd class. They could of course have scratched out the colour, but five inches of orange colouring on an exceedingly thin road? No. And if they had removed the road colour now and again, nothing would look as strange as the ‘A’ printing of the Cairngorms tourist map of 1964 with bright red road numbers beside white roads. Yes, all roads are not only uncoloured, but are a cold white, whereas on the early quarter-inch maps the soft relief colours show. Perhaps the OS wanted to avoid a repeat of Snowdon District, where the red roads really do look to have been hand coloured, and were a distraction from the spectacular scenery shown.

Which is where I started.

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David Andrews spotted this in the July 1968 edition of Readers’ Digest

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When the Queen opened the Ordnance Survey’s new building at Southampton, the military Director General’s aide-de-camp was in full dress uniform. The Queen was ushered into a lift to take her, the Director General, and some of his staff up to the conference room.

To everyone’s horror, the lift refused to work. A technician was about to be sent for when the Queen spotted the problem: “If your aide would take one pace forward, General, his spurs would stop holding the doors open.”

—John Wright, Chichester, West Sussex

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4 As was done for the unwelcome letters R.A.F. on Leuchars airfield on early printings of Scottish Popular Sheet 64, Dundee and St. Andrews leaving a distinct scuffed area. Enlarge square 12E of http://maps.nls.uk/view/74400681 and look between Aero of Aerodrome and the green wood.
Book reviews

Manchester: Mapping the City, Terry Wyke, Brian Robson & Martin Dodge, Birlinn, 2018, 978-1-78027-530-7, £30, hardback, 256pp

Scotland: Defending the Nation, Carolyn Anderson & Christopher Fleet, Birlinn, 2018, 978-1-78027-493-5, £30, hardback, 232pp

These two volumes, published towards the end of last year, are proof that Birlinn is a publisher at the top of its game. Both are magnificent large-format, full-colour productions, amply illustrated, with map extracts on almost every page and informative narrative written by experts in their field.

Manchester is organised as 54 chapters, named chronologically from 1728 to 2016. Each chapter features a specific map of that year, introducing a topic which is generally followed by other maps illustrating the same topic. 1780, for example, starts with a plan of Castlefield canal basin and goes on to include maps and discussion of the Bridgewater canal, the Rochdale canal and Bradshaw’s 1834 map of the canal network in north-west England. The narrative describes the engineering problems and the economic importance of the region’s canals.

Other chapters cover a wide range of topics relating to the city’s political, municipal, social, industrial, leisure and sporting history, including Peterloo (1819), railways (1824), Cottonopolis (1831), parks (1851), water supply (1881), slums (1904), trams (1916), football (1923), Belle Vue zoo (1958), parking meters (1960), the building of Arndale Centre in 1978 and its destruction by IRA bombers in 1996.

Few OS maps are included, which may at first seem to CCS readers to be an omission, but actually goes to show the vast range of other mapping and innovative ways of portraying geo-information that have been produced over the years. Just three of the many examples are the cab-fare calculator of 1868, the bird’s-eye view of Coronation Street and the 2014 map of facilities available for rough sleepers.

Altogether, this book is a treasure trove, fascinating to those with little knowledge of the city (and its often-overlooked Siamese twin Salford), essential for those who are familiar with it.

Scotland, sub-titled Mapping the military landscape, comprises an introduction describing the history, types and purposes of military maps of Scotland, followed by six chapters, arranged chronologically covering topics from the ‘Rough Wooing’ of the 1540s through the Jacobite rebellion and the two world wars to ‘Mapping for nuclear war’ of 2018.

Christopher Fleet is well known to Sheetlines readers as the mastermind behind the National Library of Scotland’s online maps and this volume, published in association with NLS, is testament to his deep knowledge of the library’s collection. The illustrations include not only maps, but many contemporary sketches, plans of battlefields and fortifications, and annotated descriptions of terrain, itineraries and allegiances of landowners.
Two particularly beautiful reproductions of topographic maps, out of many in the book, are General Roy’s Military Survey of 1747-52 and George Morrison’s 1750 survey of the road between Blairgowrie and Braemar. By contrast, the plain simplicity of the street plan showing the devastation of housing in Clydebank in two air raids shows how powerful maps can be at portraying catastrophic events.

Ordnance Survey maps play a relatively small role in the story, not surprisingly given the almost 500 years covered here, but some examples include extracts of 25-inch plans of barracks of the 1860s, early 20th century one-inch maps overprinted with coastal defences, security deletions during World War 2 and post-war air photo mosaics, whilst the German Army 1:50,000 map of Dundee and St Andrews is actually a photo-enlarged version the OS Popular Edition one-inch map.

Both volumes include extracts and descriptions of Cold War era Soviet maps and both have an extensive bibliography and list of sources for further research. Together with Birlinn’s other recent publications, Scotland: Mapping the Nation and Scotland: Mapping the Islands, they represent significant and welcome contributions to the canon and richly deserve a place on the shelves of everyone interested in cartographic history.

John Davies


This is an attractive coloured picture book, with forty extracts from OS maps from the General Survey of 1801, through the County Series, Explorer and Landranger, to the Vector Map Local of 2012. Each extract takes up the whole of the recto of an opening, bled to the edges, with a series of questions graded by difficulty on the verso of the same opening. The difficulty is more about how long it takes to study the extract and fall upon the answer, rather than anything to do with the mapmaking itself. The text is interspersed with snippets of information about what the OS is and what sort of things it does. Some items are very interesting, like ‘Where was the world’s first tarmac road’, and some are less so, like ‘Solve these anagrams’. Altogether the book would make a good present for a nine-year-old beginning to show an interest in maps.

Michael Spencer

Epping Forest The Official Map, City of London Corporation, 978-0-85203-089-9, £4.95

This 2018 issue is a revised edition of the 2010 map previously reviewed. It covers the fifteen miles between Ilford and Lower Nazeing and the eight from the Lea Valley to Hainault Forest at a scale of 3½ inches to the mile (approx 1:18,100 – larger than the 1:20,000 of the earlier edition), based on Collins mapping. Forest land is colour-coded in six categories, according to status or vegetation type; buildings are coded in 16 categories of use, whilst walking and cycling routes are coded in six categories. The new edition has side panels with detailed maps of nine waymarked trails. One thing unchanged is the price – remarkable value for under a fiver.

John Davies

1 Sheetlines 90, 47

The Ordnance Survey presented a serious, and ultimately fatal, challenge to private publishers of county maps. George Virtue saw the opportunity to counter this by pitching them at a more popular market, and in 1830 he started the publication by monthly parts of The English Counties Delineated. At just 1s, each part would contain an uncoloured map with sixteen fact-filled quarto pages about the county and its towns; for an extra 6d the map came hand-coloured. Much of the attraction of the maps lay in the pretty vignettes, the heraldry and the decoration. The text was contracted out to Thomas Moule, an antiquary with a particular interest in heraldry. Later on, Virtue had the maps updated with new railways and used them in Barclay’s Universal English Dictionary of 1842 with numerous subsequent editions.

What this book reproduces is a set of the county and city maps taken from the Dictionary, along with Moule's introduction, his county descriptions, and his descriptions of those towns for which maps appeared, all this being from The English Counties Delineated. The very generous size of the book (16" x 12") allows the maps to be read clearly and the price is remarkably modest, thus providing a splendid opportunity to study the cartography.

The trouble is that Virtue appears to have contracted out the cartography to hacks and not to have done much checking. Thus we find that the second most important port of Yorkshire, Goole, does not appear; presumably whatever map was being copied was of before 1826, which is when Goole was founded. Or if we go south to part of the country where the Ordnance map was available to be generalised, we find that the draughtsman has renamed Cirencester Park as Oakley Park, through conflating ‘Oakley Wood’ and ‘Deer Park’ on the one-inch. Getting the names of country houses wrong is a serious matter on a county map.

However, such points require close inspection. Because railways stand out more prominently than anything else, what strikes one most is the very limited development of the railway network at the start of the 1840s, a time too when many of the recent upsurge of ambitious new tram roads had yet to encounter competition from pukka railways. Thus on the Devon map the only railway west of Newton Abbot is the Plymouth and Dartmoor Rail Road (25 miles long, horse-worked). But one must use the maps with caution. In Lancashire the St Helens Railway (which had locomotives but which was still close to a tram road in its operation) is shown continuing along the line of the Sankey Canal and joining the Grand Junction at the future Winwick Junction. Was this a proposal that came to nothing or does it merely reflect the merger of the canal and railway in 1845? Even more intriguing is the tram road shown from Lynn to Fakenham in Norfolk, prefiguring by 35 years the Lynn & Fakenham Railway that became one of the components of the M&GNR.

Whilst one ought not to rely on the maps, there are still many things on them that clarify one’s understanding of what was going on in this incredibly dynamic period. For example, I found the map of Bath (and Moule’s accompanying text) really helpful in explaining how the great area of public open space below the Royal Crescent came into existence; and the vignettes always help to conjure up the atmosphere of the era. So the book ought to make an excellent present. One certainly wishes the publisher well; perhaps one might even look forward to a similar publication covering the maps of Bryant, a cartographer who for all his faults did often provide added value to the OS.

Rob Wheeler
Christopher Saxton, a Yorkshireman born in or near Wakefield in around 1542, was given the task of surveying the counties of England and Wales, on behalf of the Queen, when he was about thirty years of age. A letter signed by the Master of the Court of Requests and Surveyor of the Court of Wards and Liveries, instructed Mayors and Justices around the realm to accommodate Saxton by guiding him to any ‘Towre, Castle or hill to view that countrey’. His map of Cornwall, published in 1576, was one result. It is an extraordinarily beautiful piece of work, decorated in the ornate style of the Flemish school, with strapwork, fish, flowers, birds, galleons and sea monsters. It is also a remarkably accurate work of cartography, particularly when one considers the means at the map-maker’s disposal. His cartographical innovations included the use of different styles of lettering to demonstrate the relative importance of the villages, towns, forests, Hundreds etc – a technique still in use today.

Just over thirty years later, John Speed published his now widely-celebrated map of Cornwall. It too is as much a work of art as a work of cartography. In addition to the galleons and sea monsters, it contains charming sketches of, for example, the castle of Launceston, the stone circle of The Hurlers, and the natural rock formation of The Cheesewring.

These two maps, and eighty-five more, are illustrated, analysed, and discussed in Bob and Jon Quixley’s excellent and lavish account of 280 years of map-making of the Royal Duchy, and of the treacherous waters around the Isles of Scilly. This second edition considerably updates the first, published in 1966, and contains maps dating from the end of the 16th century ‘to the mid-19th century, where decorative maps decline and are superseded by the cleaner lines of the Ordnance Survey.’

I should perhaps declare an interest: in 1963, Bob Quixley (then Head of Geography and Geology at the Humphry Davy Grammar School in Penzance) ignited and kindled in this ink-stained pupil a lifelong interest in maps in general and the Ordnance Survey in particular. His knowledge of, and enthusiasm for, the maps of his county are infectious.

Andrew Darling

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1 Available at www.quixleymapbook.com.
‘Very few people understand the importance of the small unassuming building next to the lighthouse on Newlyn’s South Pier. Although it looks like another fish shed, it is in fact the Newlyn Tidal Observatory. It houses a simple domed brass bolt set in a recess in the floor. The top of this domed bolt is the bench mark for all height measurements in mainland Great Britain.’ In December 2018 it received the honour of being ‘listed’ for its interest – in company with a bus shelter and a cattle trough, which drew more attention.¹

The Ordnance Survey has used two such national datums. The first was that of Liverpool, which was related to tidal observations over a fortnight in 1844, and the second is that of Newlyn, observed over six years between 1915 and 1921. The Liverpool datum was needed in order that levelling that had already been under way for a year or so could be related to a general datum related to a mid-tide position. Like many things in the earlier history of the Ordnance Survey, what seems to have been a hasty improvisation had a long-term effect. The Liverpool datum was explicitly referred to in the footnotes of the six-inch and larger-scale surveys that began to be published from 1846 onwards, and on one-inch and smaller-scale maps from 1882 onwards. Specifying the datum continued on the larger scales, but on the smaller scales it disappeared after 1914. That the Liverpool datum was not an exact mean sea level was recognised fairly quickly, and by the 1890s a note that it was 0.650 feet below the general mean level of the sea had been added.

The disappearance of such precision from the notes to the one-inch and smaller scales seems to be related to the work at Newlyn. This can be interpreted in two ways: one is scholarly uncertainty, and the other is practical: at small scales, the user is concerned with a general idea of height rather than engineering precision. That said, such precision is served by any defined datum: only in 1861 was the first national primary levelling data published by the Ordnance Survey, and until the large-scale mapping of Britain was completed in the late 1880s engineers had either to run their own lines of levelling to connect with that already published by the Survey, or else to adopt a local datum for the purpose in hand.

Whilst the Liverpool datum was adequate for engineering purposes, it was not adequate for twentieth century geodesy. The mid and later nineteenth century attitude towards the triangulation and other aspects of the Ordnance Survey’s geodetic work was that it was like the six-inch and larger-scale surveys: something that would be executed once, and suffice for all time: a scientific absolute. Even at the outset of the 1:2500 survey in the 1850s it was realised that some topographic revision would be needed in due course, and by 1890 it was clear that periodical re-levelling would be necessary, if only because bench-marks proved subject to a high rate of loss. By 1900 developments elsewhere showed that the geodetic basis of the Ordnance Survey’s operations was also

impermanent. From the mid-1900s there was a gradual revival of geodetic activity: the determining of a new tidal datum was part of this, and also served for routine relevelling operations.

Three tidal stations were established, at Dunbar in 1913, at Newlyn in 1915 and at Felixstowe in 1917, in order to determine mean sea level for the mainland of Great Britain. Advantage was taken of the building of a new pier at Newlyn to include a self-recording tide-gauge as part of the works. The results were reviewed in 1921: they showed general agreement between the stations at Felixstowe and Newlyn, but the station at Dunbar had a mean sea level about 0.8 feet above that of Newlyn. As Newlyn faced the open Atlantic, it was chosen for Mean Sea Level, and as the permanent tidal station that would enable sea-level changes to be monitored. The observatory was housed in a building that remained the property of the Newlyn Harbour Commissioners. The seawater to work the gauge flowed in through an inlet pipe on the sheltered, harbour, side of the pier. This fed a stilling well, which was designed to even out disturbances to the level of the water, and needed periodical cleaning-out. The self-recording mechanism was worked by clockwork, and had to be wound up every Monday morning.

In 1984 the observatory was transferred from the Ordnance Survey to the National Environmental Research Council. Readings were now computer-generated and were sent to the Proudman Oceanographic Laboratory in Liverpool. For a while the automatic readings, taken every fifteen minutes, were backed up by manual readings. The observations are now entirely automated.

This well-illustrated booklet is written by a team, one of whom, Frank Iddiols, is a member of our Society. It tells the story of the Newlyn Observatory in a way that should appeal to visitors to Newlyn and to readers of Sheetlines. It will also help to ‘till the ground’ for the centenary of the adoption of the Newlyn datum in 2021. Apart from its scientific interest there is useful biographical information on the individual tidal observers – at any rate, for 1941 onwards, as earlier records are scanty. It also helps fill in the still insufficiently studied human story of the Ordnance Survey.

One wonders what became of the Dunbar and Felixstowe observatories.

Richard Oliver
During the latter part of the nineteenth century there was much discussion amongst Scottish mountaineers as to how many ‘Mountains’ there were in Scotland. Only when the Ordnance Survey had published its surveys of the whole country was it possible to study the matter in detail. The Scottish Mountaineering Club (SMC) was established in 1889. One of its members, Hugh (later Sir Hugh) Munro took on this huge task. He studied the one-inch maps; with their contours at 250ft intervals, few spot heights and fewer names; and the six-inch maps, no contours in the Scottish Highlands, some spot heights, many more names. He visited many summits himself with a pocket aneroid, supplementing the heights of those provided by the survey. The results were printed in the Club’s Journal in Sept 1891, titled *Tables giving all the Scottish Mountains exceeding 3000 feet in height*. Over the years, the OS has published revised heights for many hills and the SMC has incorporated these revisions in its listings, currently issued as a separate publication rather than being incorporated in its journal.

The practice of compleating 1 a round of all these 3000 ft mountains – ‘Doing the Munros’ – only developed slowly. Nine names are on the list for the first 60 years, that is until 1945. Since most of these individuals were members of the SMC, that Club recorded the names of all those successful people. Very fortunately it has felt able to continue that tradition, although the number of people reporting compleating has increased hugely. Currently the list has over 6500 names on it and about 200 are being added each year.

The Munro Society has been formed and its membership is open to all who have visited all the, currently, 282 summits over 3000 ft. Its members therefore have a particular interest in the accuracy of the Ordnance Survey maps at this particular height. Funds collected by this Society have, during the period 2007-2015, paid for 18 high grade differential GPS surveys of mountains of particular interest.

This book is a report of these activities and a record of the results. The new heights recorded, although by non-OS surveyors, have been to a standard acceptable to the Ordnance Survey, will be updated on their database and will be printed on forthcoming maps. Using the OS maps as their definitive basis, the SMC will then revise their published listing of ‘Mountains’.

The first pair of surveys were carried out by a professional firm, who reduced their fee in view of the publicity that they hoped to (and did) receive. The later surveys were by a team of three amateurs who had personally purchased professional grade equipment. The Munro Society itself reduced their direct costs by providing from the membership such things as porterage on the hills and transport. First job on the top of any mountain was to identify the true summit. Where there was possible doubt, an abney level was used to identify potential contenders. Then a Leica NA730 level was established on a tripod and a surveying pole, easily read to 1 mm, observed on each of these contenders. It is notable that there were no reported instances of the summit cairn needing to be

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1 This archaic spelling is traditional. Since I know it annoys some people, I shall continue to use it.
disturbed but several of the true summit being located at some distance from the supposed ‘summit cairn’. At that summit point then, the Leica Viva GS15 GNSS receiver was set on a tripod and recordings made over at least a two-hour period. This latter is the minimum time required by the Ordnance Survey before they will accept the accuracy of any proposed changes. The Ordnance Survey has a series of base stations throughout the country continuously recording GPS data. When the survey team is back at base, they can download off the internet data from up to seven base stations within 100 km of the survey point; this data being that recorded at the same time as that at the summit point. Software provided by Leica will then compare the base station data with the summit data and enable computation of the exact summit height. This Leica software enables the height to be identified to ± 5 cm. Should a potential change of status be identified (a mountain previously found to be above 3000 ft now found to be below that height, or vice-versa) then the Ordnance Survey have themselves processed the same data using specialist software developed by the University of Bern. In this case, the height can be confirmed to ± 1 cm.

The first survey attempt in late April had to be abandoned due to extreme weather. Although the remaining 18 surveys were all undertaken in the months May to September, the teams still had to undergo the full rigours of Scottish mountain weather. Tripods had to be securely weighted to withstand the gale force winds. Helpers had to be adequately clothed to withstand two hour waits on the summits. But the GPS observations were not dependent on clear weather conditions. The GPS network operates in rain and mist. Compare this with the Victorian surveyors. They would have needed clear views to nearby summits and weeks at high levels rather than just the three hours or so needed on the summit today.

So how should the overall position be viewed? It must immediately be said that the Victorian surveyors emerge with colours flying. None of them can have imagined that this one specific part of their work would be subject to such detailed scrutiny more than 100 years later. These modern measurements for the height of some of the most remote mountains in Scotland, in general, vary by only small amounts from those original Victorian surveys. Some variations in status to the previous listings do indeed occur. It is ironic that two of these are reversions to the original status given by Hugh Munro. Two hills had their height increased by the Survey in the 1970s to over 3000 ft when they themselves surveyed by photogrammetric methods but are now agreed, by these latest reports, to be below that figure. Full praise then to all those Victorian surveyors.

Peter Haigh

*Landscape histories from the air* is a new online collection of about 1500 images from Cambridge University’s collection of aerial photographs. The total collection, dating from 1945 to 2009, comprises almost 500,000 photos that show not only our ancient landscapes but also how the UK’s built environment underwent radical change in the twentieth century and on into the twenty-first. See: [https://cudl.lib.cam.ac.uk/collections/landscapehistories/1](https://cudl.lib.cam.ac.uk/collections/landscapehistories/1)

Cambridge University Library also offers a small but growing collection of online maps at [https://cudl.lib.cam.ac.uk/collections/maps/1](https://cudl.lib.cam.ac.uk/collections/maps/1)
Walter Purvis Smith OBE RICS
8 March 1920 - 11 December 2018, DGOS 1977-1985

Walter Smith was a good friend to the CCS in its early days. A north-easterner (born in Houghton-le-Spring), he was state educated and took a place in 1938 at St Edmund Hall, Oxford where his studies were interrupted by war in 1940 and he left in that year with a War Honours Degree. His wartime service began in the Royal Artillery but he soon joined the Royal Engineers. He was engaged in UK coast defence surveys – an activity that had centuries of precedence in anticipation of invasion – and in 1943 he participated in the mapping of the northern coast of France in preparation for the D-Day landings for which he received the Commander-in-Chief’s Certificate. In June 1944, nearly seventy-five years ago, he was one of the surveyors providing support for the artillery at Arromanches-les-Bains, receiving an MBE (Military) at the end of that year. His military career continued after his demobilisation in 1946 in the Territorial Army when, in 1957, he became Lieutenant-Colonel i/c 135 Survey Engineer Regiment TA.

In the meantime, Wallie (as he signed himself) had joined the newly established Directorate of Overseas Surveys, heading the first survey party in The Gold Coast (Ghana), working on the Volta River hydro-electric project. This was followed by the measuring of a baseline in Nyasaland (Malawi) and the reconnaissance of a 600-mile-long triangulation chain from Mount Mulanje to Mbeya in southern Tanganyka (Tanzania).

Wallie joined the Air Survey Company (a subsidiary of Fairey Aviation) as Chief Surveyor in 1950 and set up the Air Survey Company of Rhodesia, of which he was manager for three years. In 1975, by then Joint Managing Director of the UK Company, he took up a post as Advisor, Surveys and Mapping for two years with the United Nations overseeing, inter alia, mapping projects in support of development programmes around the world.

In 1977, Major-General Brian St-G. Irwin retired as Director General OS. The post had been civilianised during his tenure and Wallie was appointed in his place as the first, ab initio, civilian Director General of Ordnance Survey though his strong military background, and especially as commander 135 Survey Engineer Regiment, made him admirably well qualified as a strong bridge between uniform and suit. He retired in 1985 and was succeeded by Peter McMaster.

I first got to know Wallie when he joined OS. At that time, I and others were working on what became known after its editor as the ‘Seymour History’ of the organisation and we were often at Southampton, consulting materials there at a time when Southampton was still a treasure trove of documents and maps and access everywhere was relatively freely given to bona fide visitors. He always seemed to be genuinely interested in what we were doing and appreciated the need for record keeping.

In the aftermath of the William Roy exhibition at the British Library, I put together the case to the Greater London Council for the erection of a blue plaque
to commemorate the residence in the 1780s of Major-General William Roy at 10 Argyll Street in London. It was to be installed in April 1979. Would Wallie, I asked, do us all the honour of unveiling it? He agreed and it was something of a hilarious occasion. Police were positioned on the pavements to prevent the public from interrupting him while he was making his speech but they were so intent on listening to what was being said that they forgot about the public who barged past him, upsetting the dignity of the occasion but causing a gentle collapse of Wallie and the rest of us into undignified mirth. The advertising firm, Gerrard, on whose property the plaque was situated, gave a splendid reception afterwards and among all the photographs is the group shown here of Ordnance and Military Survey men of whom Wallie was, I think, the last survivor.

After that, and when the CCS was founded the next year, Wallie was greatly supportive of our infant Society, slightly amused but, I like to think, secretly very proud that he was head of the only survey organisation in the world to have a Society devoted solely to its history and products. The last time I saw him was at the official opening of the new OS HQ building on 4 October 2011. We had a long chat – his wife had just died and he was coming to terms with it in his typically stoic way, saying that millions of people in the world had to face bereavement and it was not a unique experience and he just had to get on with it. I have kept his wise words in mind. I shall remember him for all his kindnesses to me and to our Society. He had a great sense of humour and was always smiling.

Yo Hodson

*Left to right: RMW (Mike) Busk, Brig Svy Feltham; Brigadier Arthur Walmesley White, former D.Mil.Svy; WA (Bill) Seymour, editor OS History; Major-General Brian St-G. Irwin, DGOS 1969-1977; Managing Director, Gerrard Advertising; Dick Cameron, OS; Wallie Smith; Brig George Hardy (RGS, Deputy Director and Keeper, Map Room); Eric Barton D. Svs and Production, OS (later Major-General, D.Mil.Svy).*

*Heading photo: Wallie Smith unveiling the blue plaque to Major-General William Roy at 10 Argyll Street (see also Sheetlines 109, cover and page 10).*
Letters

Ferry good effort indeed!! I was expecting to see only a few dozen ferries at most. But there do seem to be a couple of cases where one ferry has been submitted under two different names. Chris Harvey’s suggestion of Marble Hill House-Ham House (Hammerton’s Ferry), for example, appears to be an earlier name for Twickenham-Ham (56 on Michael Spencer’s list, now operated by Stan Rust). Likewise, Michael’s 57, Hampton-Molesey (not Molesley, incidentally) looks remarkably like Chris’s Hampton-Hurst Park. There may be other examples.

Graham Bird

On Michael Spencer’s answers, 17 and 25 are the same ferry and what is missing is Westray (Rapness)-Papa Westray. During the summer one of the vehicle ferries does Kirkwall-Westray-Papa Westray-Kirkwall on Fridays and Kirkwall-North Ronaldsay-Papa Westray-Kirkwall on Tuesdays. Schedules differ in the winter.

Roger N Holden

Readers of the references to the Sandbanks-Swanage ferry should be aware that the ferry connects the Sandbanks and Studland peninsulas, a distance of less than 400 metres. A direct link to Swanage would require a sea passage of more than nine kilometres, definitely outwith the capabilities of a chain ferry, even neglecting the turn required round Old Harry.

Karol Gorny

My friend making a round-Britain’s-coast by bus trip has noted these buses on ferries: Sandbanks (bus service 50), Torpoint (70 etc), Gourock-Dunoon (907), Corran-Ardgour (506), Colintrave-Rhubodach (477 etc), Yell (24) and Unst (28).

Philip Pearson

I think the Torpoint Ferry also carries a regular bus service? It certainly did a few years ago when my mother-in-law was in a home there: the ferry crossing – where one could get out of the bus and walk around – lightened otherwise rather distressing visits.

Tony Kirby

A strange feature of the question is that it has no direct connection with OS.* Many ferries in group 2 convey regular bus services, surely as relevant as those in group 1. Some examples: Bus Eireann/EuroLines 871 Dublin-London via Holyhead, 880 Dublin-Leeds via Holyhead, 890 Tralee-London via Rosslare/Pembroke Dock, 40 Limerick-London via Rosslare/Pembroke Dock, 925 Dublin-Edinburgh via Holyhead (four countries!). All the above are night services apparently operating daily. Also, London-Paris and other continental cities, at least 20 daily services.

Pat McCarthy

* True, but this whole ferry question arose when I was looking at the inconsistencies in their depiction on OS mapping. They are as much part of the transport infrastructure as roads, bridges and railways and yet are frequently missing from maps. For walkers on the South West coast path or cyclists on National Cycle Route 1 in Essex, for example, whether or not a ferry exists is a major consideration [Ed].

1 Quiz answers, Sheetlines 113,62.
If *le Shuttle* is allowed (and I am entirely happy that it is) then on the same basis Transporter Bridges should be admitted. There are just two still operational in the British Isles, Middlesbrough and Newport, (both of which appear in the Bridges quiz). But the one omission from the lists which surprises me is the Dursey Island cable car, in south-west Ireland. It is said to be the only horizontal cable car (i.e. spanning water, rather than taking you uphill) in Europe. It is category 4, but not quite as pristine as cable cars in the Alps. When I returned from Dursey, the passengers waiting to go to the island were five sheep.

*David Purchase*

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**We offer our apologies to Tony Walduck, whose submission included not just the 200 ferries we credited, but well over twice that number. His full list is on the website at https://www.charlesclosesociety.org/ferries [Ed].**

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Peter Stubbs asks 2 about the change of Stanfords’ Royal Warrant from “Geographer” to “Cartographer.” I believe this was related to the change in status of the various fields of enquiry within the overall title of “Geography.”

Up to the last part of the nineteenth century, geography was primarily concerned with describing the physical shape of the world, geomorphology. About this time, practitioners in various aspects of the subject began to agitate for their specialities to be given a bigger bite at the cherry of independence, and claims were made for such fields as oceanography and cartography to be treated as sciences in their own right.

The work of the German geomorphologist Max Eckert (1868-1938) was instrumental in this change of emphasis. Eckert gained his professional qualifications in 1903, and became a lecturer at the University of Kiel, where his main subject was economic geography, with a side-line in cartography. He developed a number of new map projections, one of which is still widely used today. He wrote a textbook called *Outline of the Geography of Commerce* in 1905, helping to establish this as a separate academic discipline, and soon followed it with an article “Cartography as a Science” in the *Proceedings of the Geographical Society of Berlin* in 1907. Here he aimed to establish theoretical and scientific cartography as a discipline independent of geography *per se*.

I have no doubt that these works, and others like them, helping to distinguish the various fields of geographical science from each other, became disseminated through contemporary academia, and the importance of cartography in itself became established throughout Europe, including in Russia, at this time. Here is the answer to Peter Stubbs’ question.

After World War I, Eckert began his magnum opus *Die Kartenwissenschaft* (The Science of Maps), a two-volume work published in 1921 and 1925. Unfortunately, this has never been translated into English, but the separate status of cartography is now firmly established throughout the academic and publishing worlds

*Michael Spencer*  

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I was interested in David Jenkinson’s problematical pillar in what was the ancient parish of Salcombe Regis but is now within Sidmouth parish. According to the Devon Historic Environment Record, the pillar is currently regarded merely as an Ordnance Survey benchmark, but I am not aware of a single map that shows it, indicating that the Ordnance Survey did not recognise it as one of their own. The broad arrow symbol on government property originated in the 17th century as an attempt to deter theft (although I cannot visualise anyone walking off with the pillar) and it was therefore not confined to the Board of Ordnance.

A very good clue as to which Government Department was involved here is to be found in the recently published diaries of Peter Orlando Hutchinson, Sidmouth’s Victorian antiquary. In his entry for 28 May 1851 he wrote that ‘Close to the edge of the cliff there is an acre of ground recently belonging to the crown, on which during Napoleonic times a signal staff and telegraph were erected’, although this cannot be totally correct. During the latter part of the Napoleonic Wars the Admiralty erected a chain of shutter telegraph stations along inland hilltops enabling communication with Devonport. It branched off the Portsmouth chain at Beacon Hill on the Sussex South Downs, close to the border with Hampshire. There were eight such stations in Devon, the two westernmost being marked as ‘Telegraph’ on the first one-inch sheets published in 1809. Presumably the others were not completed when the survey was made. This system was abandoned following the Peace of Paris in 1814. Also no other source seems to refer to a signal staff at this point. But they were present on Beer Head, five miles to the east (being shown on the 1809 map), and Peak Hill, two miles to the west. Being intervisible there would have been no need for an intermediate site.

It was during the 1820s that the Admiralty realised that another telegraph system was desirable, this time using the semaphore principal. This led to somewhat different chains, with that to Devonport branching off the Portsmouth chain at Chatley Heath in Surrey where the five-storey octagonal tower has been restored. The Devonport branch is little documented, the standard work being seemingly still that produced by Geoffrey Wilson in 1976, which lists the actual or perhaps intended stations, since it never became operational. The chain in Devon was largely south of the shutter system’s route, becoming coastal at Whitlands, just inside the border with Dorset, as far as West Down, in what was then Littleham parish (now Budleigh Salterton parish). Wilson’s list of the stations includes ‘South Down (Sidmouth)’ between Beer Head and West Down, although he does not locate it precisely. South Down Farm was established some 270 yards inland of the pillar following the 1850 parish enclosure award.

3 Sheetlines 113, 36.
4 Site MDV63219.
6 At TQ090585.
7 Geoffrey Wilson (1976) The Old Telegraphs; the Devon stations are listed on page 44.
The typical sites occupied a square acre (larger area than that acquired for the shutter telegraphs), either leased or bought by the Admiralty, with the four corners identified by boundary stones, which it was normal practice to number. Although I no longer have young eyes there appears to be a figure ‘2’ incised below the date on your photograph. The pillar along with Hutchinson’s reference seem to be the only surviving indications and what is odd is that there is no trace of it on the Salcombe Regis tithe map produced just 13 years later. In marked contrast is the Littleham tithe survey of 1844, the map of which depicted the West Down station. The apportionment describes plot 1267, of exactly one acre, as ‘Telegraph and Furze’ being leased by ‘The Government’ from the representatives of Lord Rolle and by then sub-let to a John Bastin. The map (above) shows the square acre defined by the four boundary stones and within it a circle of some 35 yards diameter, either a wall or hedge, and within which the signal staff was presumably located. I would not want to venture an opinion on why the broad arrows are depicted upside down.

Although the line to Plymouth was never completed that to Portsmouth remained in use until the 1840s when it was replaced by the electric telegraph routed along the line of the London & South Western Railway to Gosport.

A G Collings

On OS 1:25,000 printed and online maps of Dartmoor, in square SX north of the 90 Northing, the contour interval is 5m and south of it is 10m. This of course leaves every other 5m contour with dead ends at the split. I understand OS use 10m interval, but 5m in flatter areas, but this makes no sense here because Yes Tor is mapped at 5m interval, and High Willhays (just slightly higher but south of the split) is mapped at 10m interval. My older printed OL28 map is 10m throughout. Does anyone know the history of this? Is it work in progress and the whole of the UK being done at 5m interval?

Nigel Machin

on ordnancemaps discussion group
Bridge quiz – solution and solvers

As many readers were eager to point out, the map extracts depicted far more than the ‘twenty bridges’ mentioned in the question! Some entries listed all the bridges found, others focused on the main road bridge featured in each extract, which were:

Kessock Bridge, Skye Bridge, Clachan Bridge, Erskine Bridge, Berwick Bridge, Middlesbrough Transporter Bridge, Humber Bridge, Thelwall Viaduct, Silver Jubilee Bridge (Widnes-Runcorn), Conwy Bridge, Menai Suspension Bridge, Queensferry, Severn Road Bridge (M48), Newport Transporter Bridge, Henley Bridge, Queen Elizabeth II Bridge (Dartford crossing), Clifton Suspension Bridge, Kingston Bridge, Medway Bridges, Tamar Bridge.

There was a record postbag of 47 entries; the successful solvers were, in order of landing in the editor’s inbox or on his doormat: Phil Pearson, Roger N Holden, Jonathan Roberts, Tony Walduck, Michael Spencer, Ian Byrne, John Savage, Malcolm Stacey, John Winterbottom, David Purchase, William and Amanda Heaps, David L Walker, Matt Ashley, Nick Millea, Peter Addiscott, John Ambler, Andrew Turnbull, Peter Yarlett, Richard and Anne Wilson, Geoff Kent, Nigel Smith, Nick Roberts, Rob Wheeler, Bill Henwood, David Sherren, Paul Swindell, Andrew Barton, Russell Johnson, David Smith, Dave Vaughan, David Ludlow, Donald Clayton, Stuart Hicks, Paul Jackson, Alan Young, Alison Ewington, Bill Hines, Alan Mais, Duncan Stewart, Lyndon Knott, Kevin Bland, Graham James, Keith Warman, Chris Harvey, Malcolm Parsons, Jim Chisholm and Richard Higgs.

The winner’s name, pulled out of the hat on 31 January, was Bill Henwood.

If you enjoy these map puzzles, you will find earlier ones in Sheetlines 90 (islands), 103 (lakes, lochs and llyns), 104 (towns), 108 (seaside) and 110 (termini), all online at www.charlesclosesociety.org/SHEETLINESARCHIVE.

This month’s challenge on page 68 is undoubtedly more difficult, but hopefully contains enough clues to reveal at least some of the identities of the small towns depicted. Possibly no one will get them all, so send your answers to the editor before 30 May and the solution judged the ‘best’ on that day wins the usual book prize.

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**Clachan Bridge, known as the bridge over the Atlantic, linking the west coast of Scotland with Seil Island**

*Photo © Copyright Bill Henderson and licensed for reuse under the Creative Commons Licence.*
Twenty small towns are shown in alphabetic order – where are they?