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The Society publishes a wide range of books and booklets on historic OS map series and its journal, *Sheetlines*, is recognised internationally for its specialist articles on Ordnance Survey-related topics.

William Mudge and the General map of England

RC Wheeler

Between 1744 and 1793, four generations of the Cassini family produced an accurate map of France, to a uniform projection (Cassini on meridian of Paris) and with a regular grid of sheet lines based on that projection. Lt William Mudge, writing on 10 April 1799 as the recently-appointed head of the Ordnance Survey, had this in mind when he wrote that one of the principal objects of the Trigonometrical Survey was ‘to collect materials for making a General map of England, in some respects similar to the Carte de France’.¹ The expression *in some respects* seems in part to have been inserted to avoid committing the Board of Ordnance. It serves also to remind us that the Old Series was a very imperfect reflection of the rigorous logic of France: the map of England used multiple meridians,² had sheets that were not quite rectangular, and a few of the joins at corners were joggled slightly.³ It was nevertheless the first map on a largish scale to cover the whole country by a grid of sheets. Previously, individual counties had been covered in this way but nothing larger.

This raises the question: how long before 1799 did Mudge conceive this idea? And when did the Board of Ordnance come to accept it? I have no new archival evidence to bring to bear on the subject, but it seems to me that the choice of sheet lines for the early maps of the Survey – their *scheming* being the technical term, as Brian Adams pointed out – does allow tentative conclusions.

Let us start with the Mudge-Faden map of Kent. The genesis of this was ‘some time before 1798’,⁴ but because of its inclusion of so much of Essex, we must assume its scheming came after the decision in 1799⁵ to press ahead with the topographical survey of Essex. The map was in four sheets, 33.5 by 22.6 inches between neatlines, using plates 35.3 by 24.3 inches.⁶ The smaller dimension here is significant in that it was almost as large as was achievable prior to the introduction of improved roller presses about 1800.⁷ The east-west dimension was probably chosen to accord with standard sizes for paper or plate. The southern edge of the map clears the southernmost point of the county by just a quarter of a mile; the northern edge lies about three miles north of the Essex shore of the Thames estuary. Inclusion of this coastal fringe of Essex was clearly important to Mudge. It has sometimes been suggested that this was for military reasons. This seems implausible. A field commander dealing with an amphibious landing in

¹ PRO WO 47/2372, quoted by JB Harley & Y O’Donoghue in the introduction to *The Old Series Ordnance Survey Maps of England and Wales*, Vol I, Lympne: Harry Margary, 1975,(henceforth ‘Margary I’) xxvi.

² Brian Adams, *Projections and Origins*, London: Charles Close Society, 2006, 48-52.

³ Notably those to the NE of sheets 11 and 12.

⁴ Margary I, xxxii.

⁵ Margary I, xxviii.

⁶ Margary I, xxxvii (neatlines). Plate measurements were made by Roger Hellyer on the NLS set. His figures for dimensions within neatlines (33.4 inches by 22.7 inches) are within variability of paper shrinkage

⁷ Personal communication A Cook.

Kent would need a good map of Kent; a field commander dealing with an amphibious landing in Essex would need a good map of Essex. The overall commander needed to decide how to apportion forces between the two counties and when to commit reserves; for this, a small-scale map would suffice. Only a *naval* commander would need a map of the whole of the estuary, and he would use a nautical chart, not a topographical map.

Why, then, did the Mudge-Faden map include this three-mile fringe of Essex? I suggest it was to satisfy purchasers from the numerous towns on the Kentish shore who might wish to identify on the map landmarks they could see across the water. To include a detailed representation of the Essex shore for no other purpose would normally be an unwarranted extravagance for a commercial map producer, but in this case the survey at least came *gratis*. Moreover, places like Hackney attracted prosperous merchants seeking plots for elegant residences within easy reach of the City; such men were perhaps seen as potential purchasers if their residences lay within the map.

For the western and eastern edges, there was limited flexibility. Within Surrey, topographical survey data seem to have been available only for a few square miles NE of the Camberwell to Sydenham road. The western boundary was perhaps chosen to include as much of London as possible without making this division too obvious. This placed the eastern boundary a mile or so beyond the Thanet coast.

But the most important decisions were to employ a projection based on the Greenwich meridian and to align the sheet lines with that same meridian. For a 'General map of England' it would have been better to use a meridian close to 2 degrees West (which is that used by the OS for current maps). In Mudge's defence, it may be noted that, because the UK mainland spans a narrower range of longitudes than France, the distortions that would result from using the Greenwich meridian on the western fringes of the country are no greater than those that the Cassinis' map faced on both the western and eastern fringes of France. Nevertheless, because the distortion increases more or less as the square of the distance from the prime meridian, a very minor inconvenience in Kent would have greatly moderated the problems potentially faced by Cornwall.⁸

All these decisions appear to have been taken in the interest of producing an excellent county map for Kent rather than one which could form the first part of a General map of England. If Mudge aspired at this date to follow the Cassinis, he was not prepared to sacrifice even the slightest current advantage for the sake of that long-term ambition.

Turning now to Essex, the first thing to note is that no attempt was made to continue the sheet lines of the Kent map. Admittedly, the size of Essex is very inconvenient for such a procedure: two rows of sheets would be needed but the

⁸ If we assume that Mudge had already decided that the maps should employ different meridians in their projections, this would not preclude the use of a single meridian for the sheet lines. As one moved further from the prime meridian, the angle between true north and the edge of the map would increase, but only linearly.

county would finish at the mid-line of the second row. Thus pragmatism may have steered the decision, but it might equally be that the Board saw the Essex sheets as another county map and had no vision, at this date, of a map of England. However, the eastern edge of the Essex sheets is so arranged that there is no land to the east of it, and this would make it possible for a set of Suffolk maps to butt up to Essex. Indeed, the coastline passes so closely to the NE corner of the Essex sheets that one is inclined to regard the arrangement as deliberate.⁹ Yet the positioning does not lend itself to the continuation of the Essex sheet lines in a grid pattern. As we know, this is what was done in due course and it led to a need for two sheets (67 and 49) to cover a strip of coast never wider than 7½ miles. Had the Essex sheets been moved 7½ miles eastwards, this untidiness would not have occurred. There would have been a penalty in that a small strip of western Essex would have been left off, but part was already covered by the Mudge-Faden map of Kent, and the rest could be dismissed as of little military significance. Perhaps the fact that the Tower of London would fall in this strip was seen as critical. Nevertheless, the easiest explanation for the Essex sheet lines is that the Board of Ordnance still thought of their product as a county map. Mudge indeed might be planning ahead, but only within the constraints imposed by the Board. Those constraints no doubt included a requirement to align the map on the Greenwich meridian, with the consequences already remarked on under Kent.

The size of the Essex sheets is 34.6 by 22.8 inches between neatlines, the plate size 36.8 by 25.2 inches.¹⁰ The plate width is a little curious: 25 inches is normally regarded as the absolute maximum prior to a step-change that resulted from the commissioning of a new press from Boulton for the Admiralty in 1800. It does nevertheless appear that the Essex sheets were printed on one of the new presses and there would have been no impediment to increasing the north-south dimension slightly. This would have meant that, when the series eventually extended to cover Sussex, sheet 5 would not have had to be extended by 1¼ inches to include Beachy Head. This extension was made not so much by an extrusion as by removing the southern neatline and having a bleeding edge instead – a very inelegant solution. All this could have been avoided by a quarter-inch increase in the north-south dimension of the new standard sheet size and by moving the northern boundary a quarter of a mile south – which would still have cleared the Essex/Suffolk boundary. Beachy Head was included in the primary triangulation, so Mudge already had its position in the same Cassini coordinates that were used for the Essex sheets. Then why did he not make provision for it? Even if the Board had not yet embraced the concept of a map of England, the modifications suggested above would seem easier to slip through than pushing the eastern boundary as far as Orford Ness.

⁹ This point was inspired by the ‘third proof’ in Richard Oliver, “The sheet sizes and Delamere sheet lines of the one-inch Old Series”, *Sheetlines* 77, 39-40, which stopped short of any implications for the coverage of Suffolk.

¹⁰ Margary I, xxxviii (for neatlines). Author’s measurements on LAO YARB 4/29/4 for plate, with neatlines measured as 34.5 by 22.9 inches.

When were the key decisions taken on the Essex sheet lines? The topographical survey was 'about to commence' in April 1799.¹¹ The areas assigned to surveyors match the eventual sheet lines fairly precisely, so the decision to push the sheets eastwards to include Orford Ness seems to have been taken by this date. On the other hand, the amount by which the sheets extended into Kent did not depend on any new survey, so the decision on the north-south dimension might have been taken as late as 1801, when engraving seems to have started.¹²

The next county to be mapped was Devonshire. As Brian Adams observed, the sheet lines appear to be aligned on the meridian of 3° West. One cannot determine the exact value used, but it is clear that the alignment does not match any of the meridians used for the triangulation (of which more later) and is sufficiently close to 3 degrees to make it probable that this exact figure was used. The choice of meridian is an interesting one, it being almost at the eastern edge of the Devon sheets and a long way away from the central meridian for Cornwall, whose sheets subsequently followed the same alignment. This seems to imply some wider consideration. I suggest that Mudge had realised that using a single meridian (necessarily now Greenwich) for the sheet lines for the whole of England was not acceptable but he hoped to get away with two meridians, 0° and 3° West. If such a scheme were adopted, the obvious place for the change of meridian would be 1°30' W. However, continuing with two full-width columns west from Essex would reach 1°42½' W, enabling almost all of Hampshire to be fitted on one alignment of sheets, with Dorset on the alignment of 3° W.

A key piece of evidence for this is the choice of the northern edge of the Devonshire sheets. Seen in isolation, this is too far north: it causes part of the Glamorganshire coast to fall within the Devonshire sheet lines - although as first published the area was shown as sea. However, if one continues the northern edge eastwards (perpendicular to the meridian of 3° W) it reaches our postulated dividing line of 1°42½' W at 51°24.66' N; the southern edge of Essex so continued is at 51°24.73' N. The difference is within the accuracy to which I have been able to determine the coordinates of sheet corners.

There is, however, a problem. The space between Devonshire and the postulated Hampshire amounts to some 72 minutes of longitude, requiring two excessively narrow columns - about 25 inches between neatlines. One might suppose that Mudge would wish to alleviate this by positioning the Devonshire sheet lines as far west as practicable. There seems scope for this: as actually drawn the eastern boundary bisects a detached piece of the county, whereas the western edge severs part of the coast around Welcomb (north of Bude), which sits unhappily on sheet 29. A slight shift westwards would have avoided this without losing any of the main part of the county at the eastern edge. Once again, we see Mudge seemingly adjusting the sheet lines in some respects to prepare the way for a map of England but neglecting other actions which ought to have been equally acceptable to the Board of Ordnance. It is as though his

¹¹ Margary I, xxviii.

¹² Margary I, xxxii.

mind was only half on the job.

As for the dating of these decisions, although authority for topographic survey had been given by the summer of 1800 at the latest,¹³ the key date in this case is the start of engraving, which is assumed to be between 1803 and 1805.¹⁴ The areas of the Ordnance Surveyors' Drawings (OSDs) are curious, with those started in 1802 (OSDs 43 and 44) stopping short of the eastern sheet edge and a long thin drawing of 1806-7 (OSD 46) filling the gap. It is almost as though the sheets were shifted *eastwards* for some unfathomable reason between 1802 and 1806. The very northernmost drawing is difficult to date; in any case, the NE corner falls in the Bristol Channel so remained flexible until engraving started.

Thus the answer to the question of when Mudge first aspired to producing a map of England is that the maps provide no positive evidence that predates his statement of April 1799 but offer weak evidence that when Kent was schemed he had no such plans. On the other hand, they do seem to show remarkable inconstancy in the pursuit of such an aim.

As for the Board of Ordnance, the strongest negative evidence is provided by the Isle of Wight sheet, seemingly aligned on 1° *East*, and thus only comprehensible as a single-sheet county map (treating the Isle of Wight as a county in its own right). The approximate sheet lines are suggested by OSD 75, surveyed in 1797, but they appear to have been shifted subsequently, as the NE corner falls within OSD 83, surveyed 1805-6. It is possible that engraving started before OSD 83 had been commenced, but it seems likely that any intervening time should be short. Thus it would seem that, as late as, say, 1804, the Board was still thinking in terms of overlapping groups of sheets, each group covering a single county.

In order to understand Mudge's inconstant pursuit of his aspiration it is worth reviewing his career. He joined the survey in 1791 as a Lieutenant; he died a General. He was evidently not lacking in ability. Those who have written about him tend to assume that this ability was manifested in running the Ordnance Survey; some tend to focus on his excellence in the trigonometric survey (regarding that as the supreme activity). It is therefore useful to note that the Board of Ordnance was quite content in 1791 to have the entire survey run by a Major who left the direction of the trigonometrical survey to Mudge as a mere Lieutenant. Sadly, the military establishment did not value technical and scientific activities as it might have.¹⁵ Promotion depended rather on having well-placed patrons, so, when we find Mudge in 1803 devoting his energy to the training of cadets,¹⁶ we should remember that his position as a kind of peripatetic headmaster provided ample opportunities to render service by helping cadets to master some inherently difficult subjects. Some at least of those cadets will have had well-placed relations, and patronage was all about conferring favours in

¹³ Margary II, xvi.

¹⁴ Margary II, xxvi.

¹⁵ For an example of this, see Mark Urban, *The Man who broke Napoleon's codes*, London: Faber, 2001.

¹⁶ Margary II, xx.

recognition of past services or the anticipation of future ones.¹⁷

Without doubt Mudge was energetic and he knew how to work the system. He was technically able and was evidently a good teacher. But I want to suggest that clarity of vision was not one of his strengths. The most damning evidence against him comes from the survey's geodetic work. He joined an organisation whose principal achievement had been the accurate measurement of a chain of triangles in order to measure the position of Greenwich relative to Paris. Underlying this had been a desire on the part of the Royal Society to determine more accurately the shape of the earth. This spirit infused the early operations of the trigonometrical survey. 'Running a chain of triangles' summarises a lot of the early work.¹⁸ As later commentators noted, there was no process of adjustment other than for single triangles. By removal of spherical excess, these triangles were solved using plane trigonometry and their sides calculated. None of this required any assumption about the shape of the earth. The next stage was to run in sequence along the sides of triangles, calculating their angle to the prime meridian and hence calculating the Cassini coordinates of their vertices. This stage also avoids any assumption about the shape of the earth, but only by assuming the earth is locally flat, so it is subject to large errors if done over anything other than a narrow strip. A third stage converted these coordinates to latitude and longitude. This did require an assumption about the radii of curvature of the earth (measured in north-south and in east-west directions). However, this stage was unnecessary for production of a map. It would therefore have been quite practicable to produce a map on the Cassini projection, to add marginal figures for latitude and longitude, if desired, on the assumption that the French had got it right (or on the basis of more tentative English measurements) and then to alter those marginal figures later if better estimates for the radii of curvature became available. That said, Mudge still faced the problem that he was producing, not a triangulation of England and Wales, but a series of triangulations of narrow strips centred on the meridians of Greenwich, Beachy Head, Dunnose, Black Down, Butterton Hill and St Agnes Beacon. The triangulation along the south coast was used to determine accurately the relative positions of these points.

As these strips were extended northwards, they would converge. If one was prepared to make some assumption about the shape of the earth, one could estimate the magnitude of this convergence. But Mudge seems to have had a more pragmatic solution: if a station on the borders of (say) the Black Down and Butterton Hill strips had its position calculated in both sets of coordinates, then the Butterton Hill coordinates could be used for anything related to it when drawing a Devonshire map, whilst the Black Down coordinates could be used for anything related to it when drawing a Dorsetshire map. This had the advantage that any accumulated errors were pushed out to the joins between sheets, and

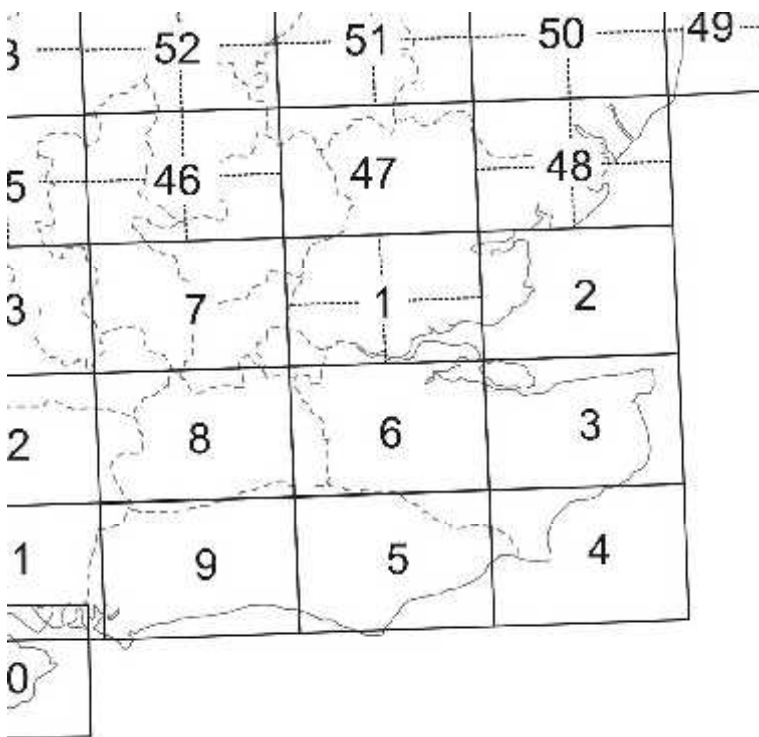
¹⁷ JM Bourne, *Patronage and society in nineteenth-century England*, London: Edward Arnold, 1986.

¹⁸ See eg *Plan of the Principal Triangles in the Trigonometrical Survey 1795-1796*, "An account of the Trigonometrical survey carried on in the years 1795, and 1796 ...", *Phil Trans* 1797, Tab XI, p542.

specifically between sheets of different counties. After a hundred miles or so, this process would produce excessive accumulated errors, so Mudge introduced new local origins as the survey extended northwards: Clifton Beacon, Moel Rhyddlad and Burleigh Moor.¹⁹

This is horribly inelegant, but it produced maps that were perfectly adequate for the military requirements of the day (which did not include indirect artillery fire between adjacent sheets). It almost entirely avoided the need to make any assumptions about the shape of the earth. Where such an assumption was needed it was hidden in fairly dense mathematics. Thus Mudge perhaps hoped to avoid the ire of those Fellows of the Royal Society who took divergent positions on the matter. And indeed he seems to have escaped any academic invective on the subject. Meanwhile, his demonstrations of the survey's accuracy focused on bases of verification, which confirmed the accuracy of his determination of the lengths of the sides of triangles - that first stage which required neither approximations nor assumptions about the shape of the earth. As a policy for advancement it worked splendidly: in 1809 he was appointed lieutenant-governor of the Royal Military Academy, in 1818 a commissioner of the new Board of Longitude, and in 1819 was promoted to Major-General. He died in 1820, firmly in the ranks of the Great and the Good.

As for the question posed at the start, Mudge's aspiration to produce a map of England may have been stated as early as 1799 but it was at least five years before the Board of Ordnance was persuaded to endorse it. Even Mudge himself was liable to be deflected when he had other things on his mind, and Mudge very frequently had other things on his mind.



Left:
Sheet lines of the Essex map as later extended south to Beachy Head (extracted from Old Series sheet line diagram drawn by Chris Higley and available on CCS website at <http://www.charlesclosesociety.org/indexes>)

¹⁹ *Projections and Origins*, 50.