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An 1840 diagram of the Secondary Triangulation of N. Scotland

David L Walker

An apparently un-noticed diagram signed off by Lt Col Colby in March 1840 sheds new light on the secondary triangulation of Northern Scotland. As this ‘1840 diagram’, measuring 100 cm by 75 cm, is on tightly folded tracing paper, and was photographed with minimum disturbance, the writer’s montage of photographs (figure 1) is disjointed. Nevertheless, as The National Archives advised that the diagram’s condition precluded making an electronic copy, the detail is preserved in figures 3 to 6 (below).

Figure 1 The National Archives (TNA), WO 55/961, Engineer Papers, Surveys, 1831-41, diagram filed at 9 March 1840.
Previous information

A previous Sheetlines article\(^1\) on ‘the initial triangulation of Scotland’ referred only to the principal triangulation, *ie* that made between stations occupied by one of the 36-inch theodolites. Consistent with Seymour’s history, which states that ‘a complete list of stations does not exist’, and the unimpressive ‘sketch diagram’ prepared at the Ordnance in 1834\(^2\) (*figure 2*) it found no evidence of the secondary triangulation of Northern Scotland.

![Figure 2](image.png)

*Figure 2  Part of a Sketch Diagram of the Principal Triangles of Scotland and its Islands, 1834.*

A subsequent article\(^3\) on ‘the troubled progress of the Scottish triangulation’ mentioned the use by other surveyors of other triangulation points attributed to the Ordnance. Most of these have now been found on the ‘1840 diagram’. After identifying considerable improvements in the 1840 diagram compared with 1834, this update reviews these other surveys and considers when these points would have been observed by the Ordnance.

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2 Lt Hastings Murphy, *Sketch Diagram of the Principal Triangles of Scotland and its Islands*, The National Archives (TNA), MFQ 1/269/13, 9 January 1834 (extracted from Maps illustrating ‘Precis of the progress of the Ordnance Survey of England and Wales 1783-1834’ by Thos Colby Lt Col RE).

Figure 3 South west quarter of Diagram showing progress made in the triangulation of Scotland (the 1840 Diagram) from TNA, OS 55/961, as above.
Figure 4 South east quarter of Diagram showing progress made in the triangulation of Scotland (the 1840 Diagram) from TNA, OS 55/961, as above.
A covering letter with the 1840 diagram, dated 9 March 1840 from Lt Col Thos Colby, Superintendent of the Ordnance Survey, addressed to ‘my dear Fanshaw’, states:4

‘I send you the diagram you asked for, shewing the progress of the triangulation in Scotland during the two last seasons. These diagrams take some time in preparation, and if this diagram is preserved, the additional progress during the next season may be added on it much more readily than a completely new diagram can be prepared. We have no record of the diagram furnished by Lt Murphy.’

Skempton’s Biographical Dictionary of Civil Engineers (2002) describes Edward Fanshaw(e) as First Assistant Inspector of Fortifications from 1830 until 1850 and active on various Ordnance committees. Lt Col Fanshawe was a member (with Lt Col Colby) of the Ordnance committee appointed in 1834 to examine the progress of the survey and apparently retained the better memory of ‘the diagram furnished by Lt Murphy’.

4 TNA, WO 55/961, Engineer Papers, Surveys, 1831-41, letter from Lt Col Colby dated 9 March 1840.
In 1837 an impressive coalition of Scottish societies had memorialized Parliament seeking ‘resumption of the triangulation and completion of the trigonometric survey of Scotland which has been so long and unaccountably suspended after it had been auspiciously commenced.’ Perhaps they would have been reassured by sight of the in-house diagram prepared in 1840. But Colby after 1840 was under increasing pressure from the Treasury, his health was deteriorating, and he was disheartened by his relationships with his superiors.

In 1843 his response to Parliament chose to refer only to progress with the principal triangulation and argued defensively that ‘secondary triangulation, survey and engraving may be put in course of progress as soon as sufficient funds are available’ and that premature effort before sufficient funds were granted would lead to ultimate disappointment. In fairness to Colby, he probably continued to regard points defined by only one side and two angles as insufficiently reliable as a basis for ‘his’ survey (even those provided to other surveyors).

Recording a new triangulation on a map is difficult when the topographical survey lags many years behind the triangulation, as it did in Scotland. Whereas the 1834 ‘sketch diagram’ tackled this problem very inadequately, the 1840 diagram was much better as:

1. For the first time, it showed an accurate diagram of the nearly-completed principal triangulation of Northern Scotland.
2. It included a large number of previously unidentified secondary points, probably observed only by an intersection and calculated from one side and only two angles.
3. The coastline is relatively accurate, much of it apparently taken from the 1807 map by Aaron Arrowsmith (whose superb documentation is in the Society archives).
4. Unusually, it seems that the Ordnance copied an accurate coastline of the Shetland Islands from the Admiralty chart by Mr George Thomas published in 1838 (and continued to use this for its trigonometrical diagrams made in the 1850s).
5. It is one of the few maps of Scotland that meet the requirement of the Islands (Scotland) Act 2018 that ‘the Shetland Islands must be displayed in a manner that accurately and proportionately represents their geographical location in relation to the rest of Scotland.’

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5 Memorials from Public Bodies in Scotland, British Parliamentary Papers (HC), 1837(525), XXXIX, 507.
7 Paper by Thomas Colby Col RE, British Parliamentary Papers (HC), 1843 (246) XLIX. 137-139.
8 Memoir relative to the construction of the map of Scotland, publ Aaron Arrowsmith, 1809, CCS/OS/379/7.
9 The Shetland Isles, surveyed by George Thomas, 1833, Admiralty chart 1118, NLS maps website.
**Map of the County of Sutherland made by Burnett and Scott in 1831-32**

Several editions of this path-breaking map of Sutherland are catalogued and may be examined on the much-appreciated website of the National Library of Scotland (NLS). Burnett and Scott dedicated this map to their sponsor, the Duke of Sutherland, and its title states that it was made on the basis of the Trigonometrical Survey of Scotland.\(^\text{10}\)

A search of the NLS index of the very extensive archives of the Sutherland estate failed to reveal any correspondence with the Ordnance or any provision of trigonometrical information. However, Burnett and Scott’s expenses vouchers provided illuminating evidence of their survey journeys, their equipment and the persons they employed.\(^\text{11}\)

Seeking evidence of trigonometrical information from the first version of Burnett and Scott’s map, the NLS maps curator, Chris Fleet, was pleased to point to a faint ‘baseline’ between Ben Hutick and Ben Roy. Further examination of the map revealed more trigonometrical points, shown in *figure 7* by a dot in a tiny circle (not to be confused with the ‘pictish towers’ marked P.T.).

![Figure 7 Part of Burnett and Scott’s Map of the County of Sutherland, 1831-32 (see above).](image)

Trigonometrical points found on Burnett and Scott’s map are identified in blue in *figure 8*. These must have been observed by the Ordnance before 1831, and therefore before it left Scotland for Ireland in 1823. But there is, at most, only

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\(^\text{10}\) Gregory Burnett and William Scott, *Surveyors to His Grace the Duke of Sutherland, Map of the County of Sutherland made on the basis of the Trigonometrical Survey of Scotland in the years 1831-32*, National Library of Scotland. The version catalogued as Dep.313 3624/7 shows a number of trigonometrical points.

one trigonometrical observation of any of these points in Clarke’s 1858 account of the principal triangulation.¹²

Dawson’s contemporaneous account of Colby’s survey season in Scotland in 1819 describes his breath-taking treks, first to the North Coast and then to Skye, each there and back from Corriehabbie and together covering 1,099 miles in 44 days. It is hard to imagine that they could have carried any theodolite at this rate of progress. This is confirmed by Dawson, on trek, recording the construction of piles (or cairns) but not mentioning any observations,¹³ and by the account of Colby ‘ready to come shooting or fishing [with the laird of Gairloch] while his men carried on routine work.’ ¹⁴

It follows that the secondary points in eastern Sutherland, although unrecorded in Clarke’s account, appear to have been observed by intersections from the principal stations in eastern Sutherland that were occupied by Colby’s team later in 1819.

¹² *Account of the Observations and Calculations of the Principal Triangulation etc*, Drawn up by Captain Alexander Ross Clarke under the direction of Lt Col H James etc, Ordnance Survey: London, 1858.


¹⁴ Nevis Hulme helpfully reminded the writer of this report of Dr John Mackenzie’s recollections in *A Hundred Years in the Highlands*, as reviewed in Cairngorm Club Journal No 58, January 1922, 190.
George Thomas’s survey of the Orkney and Shetland Islands

Mr George Thomas, Admiralty surveyor in home waters from 1811 until 1847, was a much-respected hydrographer whose meticulous records survive at the UK Hydrographic Office and The National Archives. His charts of the Orkney and Shetland Islands were based on calculations lodged at the Hydrographic Office in 1830. Starting from a baseline between Ben Cheilt and Ben Wyvis, Thomas recorded 105 triangles reaching as far as Saxavord in the north of Unst.

Thomas’s triangles were plotted on his well-preserved triangulation diagram that extends from Duncansby Head on the mainland to Out Stack, the northernmost rock of the Shetlands. For the Orkney and Shetland Islands, this shows all of the principal stations listed by Clarke in 1858, most of the secondary points shown in the 1840 diagram and some additional points defined and mapped by Thomas. Figure 10 provides examples.

15 David I Walker and Dr Adrian Webb, The making of Mr George Thomas RN, Admiralty Surveyor in Home Waters, The Mariner’s Mirror, 104:2, May 2018
16 G Thomas, Triangles for the survey of the Orkney and Shetland Islands, UKHO, MP 98, 107-116.
17 G Thomas, Projection of triangles for the survey, UKHO, plan 530a Dr, 1827.
But to what extent was this triangulation Thomas's own work? His surveys of, for example, the shoals off the Essex coast, demonstrate that he made good use of the published Ordnance triangulation to establish a baseline, but also recorded a rigorous check of the under-lying Ordnance calculations. As it is unlikely that the Ordnance added Thomas's observations into its 1840 diagram, it seems that the secondary as well as the primary points were observed by the Ordnance during its 1821 expedition. When Thomas wintered in Woolwich between his northern surveys, his reputation at The Tower was such that he would have had no difficulty in procuring a copy of the Ordnance observations and in checking, tabulating and plotting the triangulation in his own rigorous manner.

However an interesting question remains. When the meticulous Thomas tabulated the triangles, he distinguished between ‘angles observed’ and angles deduced from the other two angles of a triangle. For example, at Ben Hope, a key point in north west Sutherland, Thomas shows the angle there between Ben Wyvis and Ben Cheilt as ‘observed’, but the Ordnance does not record Ben Hope as a principal station. So did he or anyone else make observations from Ben Hoy before his calculations were completed, prior to 1830?

**Ordinance data provided for hydrographic surveys of the northern coasts**
The nineteenth century Admiralty surveys of the northern coasts of Scotland were commenced by Commander Slater, from the Firth of Tay in 1832 until his death near Thurso in 1842. Commander Otter then took his place, working from Caithness as far as Loch Inver on the west coast by 1849. They each made good

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18 G Thomas, *Relative positions of the Gabbard Shoals from the nearest coast*, UKHO, plan D808 Dg, 1824.
use of data provided by the Ordnance to construct their own more detailed triangulations between a series of staging points towards the ends of each survey sheet, about ten to fifteen miles apart. These staging points were mainly at an Ordnance principal station, where available, or at one of the secondary points that now appear on the 1840 diagram. Alternatively, Slater or Otter himself would have to triangulate an intermediate point.

Slater's survey from Stonehaven to the Moray Firth relied upon Ordnance positions supplied by Captain Robe RE in 1835 of the principal stations occupied between 1814 and 1817. Slater also used the secondary points at Rattray Burrow and Troup Head, shown in the 1840 diagram, that could have been intersected only in those years. In 1841, finding an inconsistent longitude at the secondary point of Dornoch Spire, Slater secured confirmation of his own figures and a handsome apology from Captain Yolland RE for an error in the Ordnance calculations.20

For Caithness, detailed triangulations (figure 11) were made by Slater's lieutenant Kortright21 between Dunnet Head, Duncansby Head, Freswick Hill, Noss Head and Ben Cheilt., all of these being points shown in the 1840 diagram:

![Figure 11 Diagram of Kortright's triangulations plotted on a UKHO index diagram.](image)

For the north coast of Scotland, Otter’s triangulation book 22 records his observations of a series of triangles measured from a baseline between Roan Island and Ben Hutig, using positions provided by the Ordnance in July 1843 (figure 12). His records show that this triangulation extended eastwards as far as the Ordnance points shown on the 1840 diagram at Strathie, Forss and Dunnet Head.

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20 UKHO, SL 6b, 20 July 1841 and LP1857 Y, f37, 26 July 1841.
21 Kortright, Lt A, Angle Book for the Coast from Noss Head to Bruen Stations, UKHO, Miscellaneous (Triangulation) Books, SFD 9/28/1.
22 Otter, Cmdr H C, Misc 35 Ledger No 1, UKHO, Miscellaneous (Triangulation) Books, SFD 9/27/1.
For the north west coast, Otter again used Ordnance points shown in the 1840 diagram as staging points for his own triangulations. The copy on the NLS website of Otter’s fair copy chart of Handa Island to Rhu Stoir \(^2\) provides a good example (figure 13).

![Figure 12 Part of the first page of Otter’s triangulation book](image)

**Figure 13 Compilation of parts of Otter’s fair copy chart UKHO, L5760 14e and positions from copy on NLS website.**

**Accuracy of the 1840 diagram**

Nevis Hulme, from his knowledge of the place-names of Wester Ross, contributed a nice comparison showing the 1840 diagram superimposed on Google Earth, co-located on a baseline between Ben Wyvis and Carn Chuinneag (figure 14). In most cases the location of the peaks marked by unfilled black circles on the 1840 diagram compares well with their present-day locations, marked with a black dot in a circle on the Google map. While the 1840 coastline is imperfect, it is good enough to make sense of the diagram.

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\(^2\) Otter, Cmdr H C, *Handa Island to Rhu Stoir*, UKHO, L5760 14e, and NLS, Dep.313/3623/17, 1846.
Figure 14 Nevis Hulme, 2022, Comparison (for Wester Ross) of the 1840 diagram with Google Earth

Conclusions

The 1840 diagram is of interest in confirming progress in the secondary triangulation of Northern Scotland that can only be inferred from other sources. It demonstrates a nice example of collaboration between the Ordnance and the Admiralty in defining an accurate coastline of the Shetland Islands that was used for Ordnance diagrams from 1840 onwards.

From the title of the 1840 diagram, it might be assumed that all of the secondary points were observed in 1838 and 1839. However, this article suggests that those in the north east were observed in 1817 or 1819, those in the Orkney and Shetland Islands in 1821, and those in Uist and the Inner Hebrides in 1822. Other points in the north west, including Harris and Lewis, and North Rona and Sula Sgeir, presumably were observed in 1838 and 1839.

Lt Col Colby has been criticized, in his time as Superintendent of the Ordnance Survey and subsequently, for his reluctance to publish information on its progress. Failing, consciously or unconsciously, to share the 1840 diagram outside the Ordnance may be regarded as part of this pattern of behaviour. Yet the 1840 diagram may also be regarded as a tribute to Colby’s achievement in observing sufficient secondary points to provide the basis for the hydrographic survey of most of the Scottish coast and the topographical survey of a number of Scottish counties.

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