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“Struve revisited”

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The Charles Close Society was founded in 1980 to bring together all those with an interest in the maps and history of the Ordnance Survey of Great Britain and its counterparts in the island of Ireland. The Society takes its name from Colonel Sir Charles Arden-Close, OS Director General from 1911 to 1922, and initiator of many of the maps now sought after by collectors.

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.

## *Struve revisited*

### *From JR Smith*

It was interesting to see mention in *Sheetlines* 96 of the Struve Geodetic arc. As one of those in at the start of the long journey to make it a World Heritage Monument, I would like to fill in some of the background and comment on the future.



It was at a scientific conference in Tartu, Estonia in 1993 and then at the FIG (International Federation of Surveyors) conference in Melbourne in 1994 that the first seed was sown by Seppo Harmala of Finland. He presented a paper by Aarne Verio about the Struve arc and in it asked whether it might be appropriate to try and get it recognised as a UNESCO World Heritage site. After a slow start, the FIG History group started to make contact with other interested parties and work was done to get all ten of the countries through which it passed to take an active part. In 2002, at a meeting in Tallinn, Estonia, the Finnish equivalent of the Ordnance Survey volunteered to take the preparation of the documentation under its wing. This allowed a submission to be made and at its 2005

meeting in Durban the World Heritage committee endorsed the inscription of the site on its list. No one was more surprised at this acceptance than those who put the submission together. Not only did the triangulation bear no relation at all to any other World Heritage monument (eg the Pyramids, the Taj Mahal, the Stone City of Zanzibar etc), as it was no more than 34 survey markers, but it was spread through ten countries. Strangely it was these apparent negative aspects that worked to its advantage. Until then the most countries involved in any one UNESCO site was two. Here was a site in ten countries that could well help to bring cooperation between them. A good plus point. Then the fact that it was a scientific site broke new ground and proved to be a second plus point.

So now the chain of triangulation, measured between 1816 and 1852 stretching from Hammerfest in Northern Norway to near Ismail on the Black Sea, has a representative selection of 34 points marked and maintained by the local communities.

But that is not the end of the story. FGW Struve (after whom the arc is named) was a good friend of another astronomer, David Gill, who was later to become HM Astronomer at the Cape (in Cape Town). In correspondence and technical documents they each held the dream of how scientifically useful it would be if there was an arc from northern Norway to South Africa. Gill initially took this idea on board by initiating in the late 1800s a geodetic arc from South



Africa towards Cairo which was to become known as the Arc of the 30th meridian. By the time he retired in 1906 much of the triangulation to East Africa was complete. Unfortunately during 1910 to 1930 nothing was done but then DOS (Directorate of Overseas Surveys), did a section under Hotine, and other work was done in Egypt and the Sudan such that by 1950 there was just a 600 mile gap to be completed. This was particularly difficult survey territory in Southern Sudan but the Americans came along in 1954 through their AMS (Army Map Service) and completed the chain from Port Elizabeth to Cairo.

To join up with the Struve arc there was not only triangulation required in Central Europe but also a method for crossing the Mediterranean Sea. Most of the necessary European triangulation was completed between the two World Wars, particularly by Poland which at that time had far more territory that it does today. Crossing the sea from North Africa to Crete was executed by the American Air Force in 1954 by using Hiran (high-precision electronic ranging system adapted for geodetic measurements over very long distances). Hence the 30th arc was finished in 75 years and the overall arc of 105° of latitude completed.

The unfortunate part was that the completion happened around the time that satellite technology was coming into being and with it better ways for determining the parameters of the shape and size of the world.

Work has been done in gathering together as much data about the Central European and 30th arcs as possible and there is the hope that in a few years time a case will be submitted to UNESCO for the enhancement of the existing Struve arc site to encompass the whole from Hammerfest to Port Elizabeth and realise the dreams of both Struve and Gill albeit around a hundred years after the death of Gill.



*Previous page: Memorial at Hammerfest*

*Above: Southern terminal mark of Struve arc at Staro-Nekrassowka*

*Far left: Southern terminal of the 30th arc at Buffelsfontein (Port Elizabeth)*

*Near left: A station near the Northern end of the 30th arc near Cairo*

*[Photos: previous page Barbara Jones, this page Jim Smith]*

***From David L Walker***

Thank you for drawing our attention to the magnificent trigonometrical survey organised by Wilhelm Struve between 1816 and 1855 from the Black Sea almost to the North Cape. But your suggestion that William Roy and his successors were interested only in map-making, and not in the shape of the earth, is nicely calculated to provoke correspondence.

Certainly William Roy in 1787 admitted that, while his immediate purpose was to ascertain the relative situations of the Royal Observatories of Greenwich and Paris,<sup>1</sup> his ultimate objective was ‘to lay the foundation of a general survey of the British Islands’. However, his paper included a wide-ranging review of research into the shape of the earth, including the first Lapland arc, and made detailed proposals for contributing to ‘the united efforts of enlightened nations’ towards ‘the determination of the magnitude and figure of the earth’.

Then in 1803 William Mudge chose to publish his measurements of three degrees of the meridian,<sup>2</sup> from Dunnose in the Isle of Wight to Clifton in Yorkshire, which unfortunately failed to support the prevailing view that the earth’s shape was oblate (slightly flattened at the poles). Mudge (probably correctly) attributed this anomaly to the uneven gravitational attraction of neighbouring strata affecting his astronomical observations, and was much offended by the publication by the Royal Society in 1812 of Joseph Rodriguez’s paper<sup>3</sup> which suggested the anomaly might instead be attributable to observational errors.

Perhaps it was as a result of this dispute that Thomas Colby<sup>4</sup> ceased to publish his survey results, in 1813 devoted more attention to measuring Scottish latitudes than to triangulation, in 1817 indulged in a fruitless expedition to the Shetlands with the French geodesist Jean Biot, and around 1840 perceived the need to refine the primary triangulation, more to meet geodetic standards than to support the topographical survey.

Fortunately Alexander Ross Clarke emerged in the 1850s to bring this work together<sup>5</sup> but the title of the paper he ghosted in 1856 for the Director-General, Henry James, ‘*On the Figure, Dimensions, and Mean Specific Gravity of the Earth, as derived from the Ordnance Trigonometrical Survey of Great Britain and Ireland*’ at least gave the impression that they were more concerned with the shape of the earth than with mapmaking.

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<sup>1</sup> Major General William Roy, ‘An Account of the Mode Proposed to be Followed in Determining the Relative Situation of the Royal Observatories of Greenwich and Paris’, *Phil Trans R Soc Lond*, 1787, 77

<sup>2</sup> Major William Mudge, ‘An Account of the Measurement of an Arc of the Meridian etc in the Years 1800, 1801 and 1802’, *Phil Trans R Soc Lond*, 1803, 93

<sup>3</sup> Don Joseph Rodriguez, ‘Observations on the Measurement of Three Degrees of the Meridian Conducted in England by Lieut Col William Mudge’, *Phil Trans R Soc Lond*, 1812, 102

<sup>4</sup> JE Portlock, *Memoir of the Life of Major-General Colby*, London: Seeley, Jackson & Halliday, 1869

<sup>5</sup> Lieut Col Henry James, *Phil Trans R Soc Lond*, 1856, 146

Then in 1858 Clarke's massive *'Account of the Observations and Calculations of the Principal Trigonometrical Survey and of the Figure, Dimensions and Mean Specific Gravity of the Earth as derived therefrom'* devoted no less than 220 pages to geodesy. It is a tribute to nineteenth century communications and to both personalities that, even before the final compilation of all of Struve's work, Clarke's calculations of the earth's shape took full account of the Russian arc of 25 degrees 20', which he described as 'a magnificent work calculated in a systematic and masterly manner'.<sup>6</sup> In a further demonstration of the interest of 'the military' in the shape of the earth, the Ordnance Survey with the Astronomer Royal in 1861 readily accepted an invitation from Professor Struve to collaborate in measuring 75 degrees of longitude at latitude 52 degrees from the Urals to the west of Ireland.<sup>7</sup>

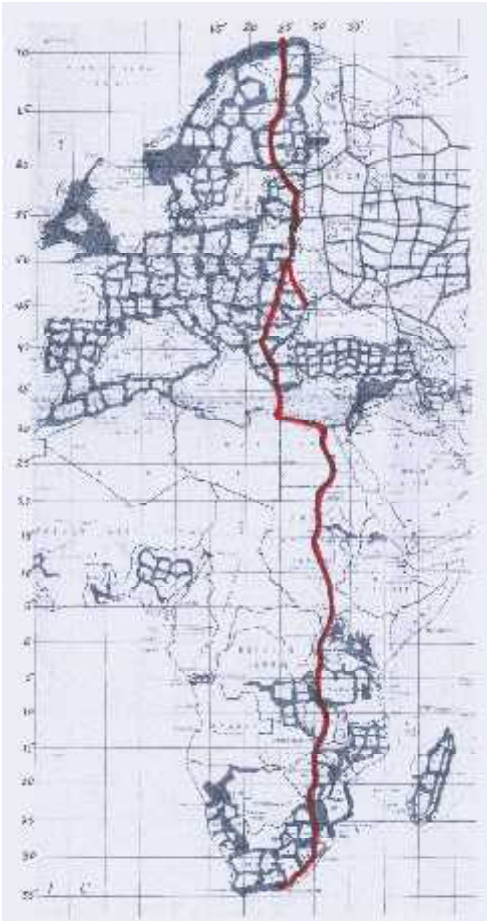
### **From Barbara Jones**

I was interested to see the piece about the Struve arc in *Sheetlines* 96. My husband and I were sailing in Norway in June 2005 and came upon the memorial at the north end of the arc in Hammerfest. We also went up Lille-Raipas, 287m, near Alta, the site of one the stations further south (*below and opposite*). Possibly the rock cairn is the original Struve Arc one? Plaques at both sites read "Inscribed upon the UNESCO World Heritage List, 15 July 2005. The arc from the Black Sea to the Arctic Ocean has been used to determine the size and shape of the earth. The survey, carried out 1816 to 1855 was pioneering scientific work of outstanding universal value, deserving protection for the benefit of all humanity." Incidentally, on the Hammerfest memorial the dates are given as 1816 to 1852 (*see picture on page 23*).



<sup>6</sup> Alexander Ross Clarke, [title as above], London: Ordnance Survey, 1858, p752

<sup>7</sup> WA Seymour (ed), *A History of the Ordnance Survey*, Folkestone: Dawson, 1980, p144 [this book is now available online at [www.ordnancesurvey.co.uk/oswebsite/docs/ebooks/a-history-of-the-ordnance-survey/index.html](http://www.ordnancesurvey.co.uk/oswebsite/docs/ebooks/a-history-of-the-ordnance-survey/index.html)]



### ***Footnote by JR Smith***

Barbara Jones raises a query about the date of completion. Struve in his report divided the whole exercise into four periods. 1812-1830, 1830-1844, 1844-1851 and 'after 1851'. The basic project was completed by the end of 1851 but there were still some tasks to be completed. Final details reached Struve in 1855. So the date on the Hammerfest monument was possibly given as 1852 as being the end of the main work in that area. The report is not very specific about dates. The monument itself has had a varied existence including disappearing at one stage when the area was threatened by invasion, only to re-appear later (if I remember correctly), in Trondheim.

Lille-Raipas takes a while to reach but well worth the climb. I was at the unveiling of that plaque (and the one in Hammerfest). As suggested, the pile of rocks could well have been raised by Struve. However in 1896 a new cairn was built at the same place. Today there is no cairn but an iron marker indicates the position of

the Struve point of 1846. The report reads as though Struve's assistant, M Klouman could well have done the observations at this station. It should also be mentioned that as well as Struve there was General Carl Tenner. In effect the whole Arc was observed in two parts, Struve starting from the vicinity of Dorpat (Tartu) and going northwards, Tenner starting from south of Livonia and working south on his own initiative and for some while, unbeknown to Struve. So theoretically it might have been better called the Struve-Tenner Arc.

*Above: Struve and the 30th meridian; from Hammerfest to Port Elizabeth*

*Right: Lille-Raipas summit cairn [photos opposite and right Barbara Jones]*

