"Brightling and the principal triangulation"

Robert Fenner

Sheetlines, 115 (August 2019), pp3-7

Stable URL: https://s3.eu-west-2.amazonaws.com/sheetlines-articles/Issue115page3.pdf

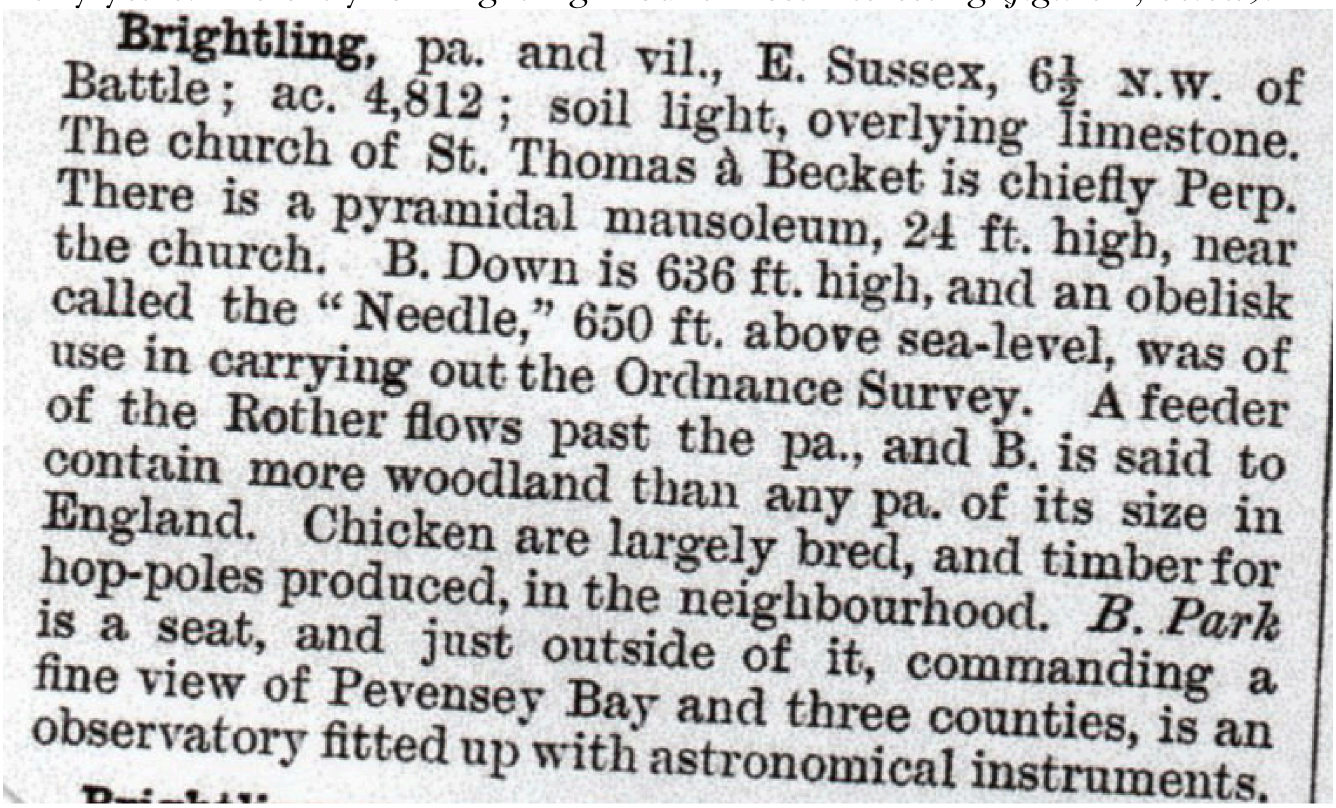
Brightling and the principal triangulation

Robert Fenner

On a recent visit to the National Trust property Batemans, Kipling's home in East Sussex, I passed by the village of Brightling. Here two things immediately drew my attention, an observatory dome and a few hundred metres north an obelisk. To someone who had spent over thirty years of his life in the geodetic branch of the OS as a field surveyor such objects have a particular relevance as likely intersected trig points. The name Brightling rang some distant bell within me and some days later at home in Worcester I did a little research.

Firstly to the OS trig archive and certainly the obelisk is a listed trig, fixed in 1949, but no mention of the observatory. Looking at old triangulation diagrams of the principal triangulation I realised where I had seen the name Brightling before. It is shown as a primary trig point. The internet shows the observatory to have been completed in 1818 but before that, in the late-18th century, a triangulation for the map of Sussex seemed to terminate at a station called Brightling Down. The main triangulation heading east reached there in 1822, four years after the observatory was built, continuing again in 1844 and the station, referred to as Brightling was presumably the observatory dome. The interval 1822 to 44 was the result of Colby and his surveyors being given a priority task with the triangulation of Ireland.

A further place of reference was Cassells Gazetteer of Great Britain and Ireland. A six volume 1893 edition has been passed down within my family for many years. The entry for Brightling I found most interesting (*figure 1, below*).[1]



Brightling, pa. and vil., E. Sussex, 6½ N.W. of Battle; ac. 4,812; soil light, overlying limestone. The church of St. Thomas à Becket is chiefly Perp. There is a pyramidal mausoleum, 24 ft. high, near the church. B. Down is 636 ft. high, and an obelisk called the "Needle," 650 ft. above sea-level, was of use in carrying out the Ordnance Survey. A feeder of the Rother flows past the pa., and B. is said to contain more woodland than any pa. of its size in England. Chicken are largely bred, and timber for hop-poles produced, in the neighbourhood. *B. Park* is a seat, and just outside of it, commanding a fine view of Pevensey Bay and three counties, is an observatory fitted up with astronomical instruments.

[1] Page from Cassells Gazetteer.

Whilst referring to the obelisk it says the Ordnance Survey found it most useful in carrying out their survey. Puzzling because being an intersected trig point there would be no surveyor activity at the site. More likely the reference was to the nearby observatory, which if it was a primary trig point, occupied or just intersected, would have involved some surveyor activity. This could have been heliostat or light keeping operations in order that the point would have been identified from the surrounding distant primary trig points. This may well have created local attention.

Following this I referred to the *Account of Principal Triangulation* [2] where the description of stations and the observations taken at them are shown. Interestingly, no description of a Brightling station or observations from it are shown. However, from six surrounding stations Ditchling, Crowborough, Wrotham, Frittenfield, Fairlight and Beachy Head observations are shown into Brightling observatory dome. One old diagram also shows a ray from the primary Butser, 100 kilometres to the west but it is not listed in the Butser observations. Presumably the observatory dome was an intersected primary point, hence no description or observations in Clarke.

Verifying the fact that it was a coordinated station, the 1908 edition of the 25-inch County series plan shows the appropriate symbol. It also shows a bench mark within the observatory, which until I saw the plan I hadn't realised had an opening within it (*figure 2, below*).

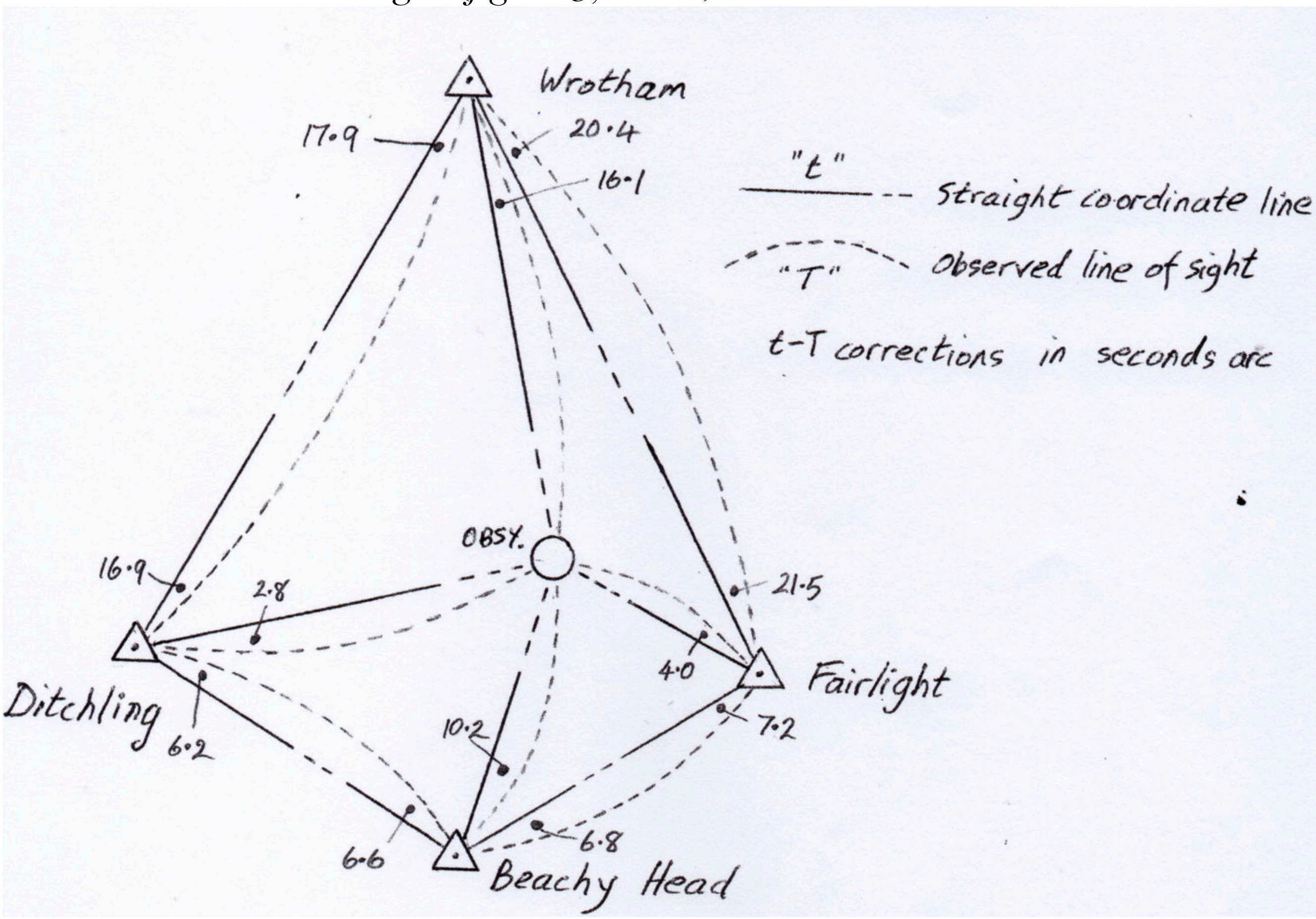
The principal triangulation has always been a fascination to me despite being employed on its replacement the retriangulation for much of my life. The Davidson committee with Hotine's recommendations no doubt justify the reason for the retriangulation, but I sometimes wonder whether a more thorough resurrection of the old stations followed by a patching up where necessary would have been a possible alternative. As it was the retriangulation after adjustment was tied to eleven of the old principal triangulation primary trigs spread across the country, as so many precise astronomic observations for latitude had been made previously, and added to that its orientation was obtained from Greenwich. In subsequent years particularly the sixties, the retriangulation was greatly strengthened by many of its sides being measured by tellurometer or geodimeter; about a dozen precise azimuths were observed, at locations over the full extent of the triangulation and at some, precise astronomic latitude and longitude was also observed. All of this together with further observed and measured connections to the French and Irish triangulations, enabled scientific adjustments of the triangulation to be made.

---

2 AR Clarke, H James, *Account of the Observations and Calculations of the Principal Triangulation,* London, 1858.

In the hundred years since the principal triangulation theodolite design had changed considerably, particularly in portability and convenience of use with the Geodetic Tavistock being able to be carried on a man's back, as opposed to the Ramsden theodolites being transported in their own well sprung horse drawn wagons. The accuracy had improved but not greatly; the retriangulation claimed an average triangle closure of 1.2" arc and was about double that previously.

Brightling got me thinking about my own very small check on the quality of the 1844 observations. Using observations from four of the previously mentioned stations that observed into Brightling observatory dome and combining them with the retriangulation NG coordinates I would attempt to derive NG coordinates for the observatory dome. This would enable me to assess the accuracy of the observations in three stages (*figure 3, below*).



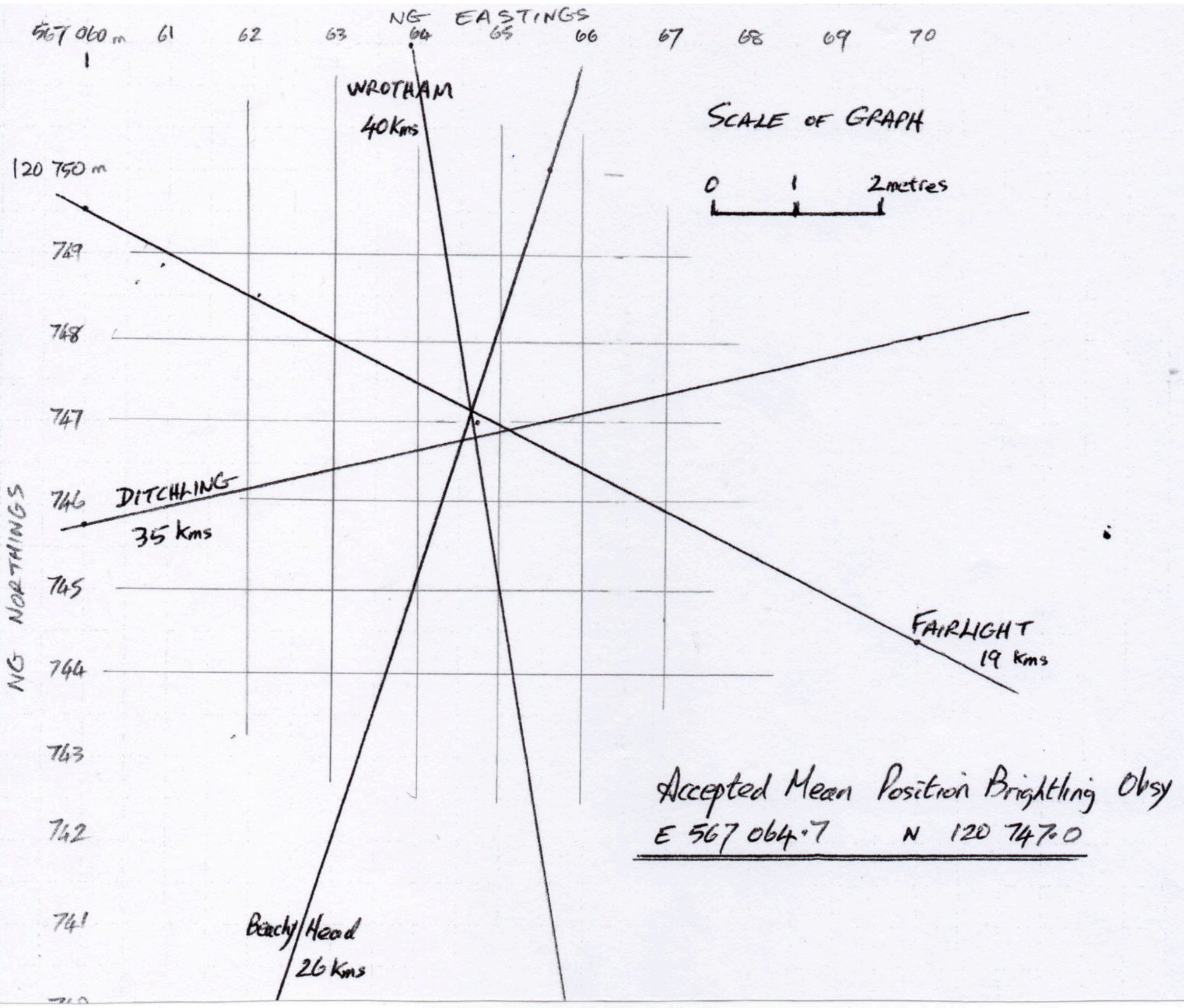
Firstly, the closure of the quadrilateral surrounding Brightling should add up to 360° plus the spherical excess. This spherical excess is proportional to the area of the triangle or figure and can be considered as 1" arc per 197 square kms. The quadrilateral has an area of 1630 square kms.

Wrotham	56°	37'	00.0"
Fairlight	95°	02'	27.5"
Beachy Head	113°	46'	42.3"
Ditchling	94°	33'	56.6"
Total	360	00	06.4

Spherical Excess 8.3"
Quadrilateral Misclosure – 1.9" arc

Having passed the first test satisfactorily, the second test is to see how well the derived directions into Brightling from the two stations either side for each of the intersecting rays compare. The average discrepancy was an acceptable 2.1" for the four directions.

Finally, by computing the intersections of the four rays and plotting the result graphically (*see figure 4, below*) the accuracy of the observations becomes readily apparent and would suggest a mean positional accuracy approaching a tenth of a metre.



Because of the distance of the intersecting rays, up to 40 kms, corrections need to be made to the straightforward bearing computed from the station coordinates – this being "t". The line of sight observed or geodesic becomes a slight curve to the projection and is known as "T". The difference t – T varies with the length of the rays, their directions and their position on the projection. In this computation they are shown in the diagram and varied from 3" to 21" arc. For those interested details of this correction and formulae for its deduction, these are shown in an excellent OS publication *Constants, formulae and methods used in Transverse Mercator Projection*.

All in all, I feel in its very small way the exercise was a fitting tribute to the quality of principal triangulation. I never cease to wonder at the effort that was put into this great feat. We mostly know about incidents like the instrument set up on St Paul's Cathedral, but that was one of several similar, such as Thaxted church spire in Essex, not to mention Norwich cathedral spire 300 feet above the ground (*see figure 5, below*). These precarious positions became necessary, as unlike the retriangulation in flatter areas such as East Anglia, they did not have water towers or specially erected "Bilby" survey towers. When reading the description of Norwich Cathedral instrument set-up, I couldn't help but notice the adjacent reference to a station on North Rona. This to me in 1983 was perhaps the remotest and most difficult place to reach in the UK. After a chartered fishing boat from Stornoway failed because of adverse weather to get us there, we used the services of the Northern Lighthouse Board ship and helicopter. In 1850 the trip must have been at the mercy of the sailing craft of the day. But not content to take the massive theodolite there, they also took the cumbersome great zenith sector instrument to determine astronomical latitude.

> North Rona, 1850. This station is on the south-east and highest point of the island of this name, about 47 miles north-north-east of the Butt of Lewis. The hill is 355·2 feet above the level of the sea, and is very precipitous on the east side, but sloping gently towards the west. The zenith sector station of the same name is 24 feet north-north-west of the trigonometrical station, and both are marked by holes bored in the rock.
>
> Norwich Spire, 1844. This station is on the top of the spire of the cathedral church of the city of Norwich in the county of Norfolk. The vane and the upright stone were removed, and the instrument placed on the flat stone composing the leaves of the finial, the centre of the instrument coinciding with the centre of the vane. The observatory was supported by a scaffolding built round the spire, and connected at various heights with its inside frame-work to within 30 feet of the top, above which height the scaffolding supported itself quite independently. The height of the scaffolding was 81 feet, and the instrument was 299 feet above the ground.
>
> Thaxted Church Spire, 1844. This station is immediately over the centre of the coping-stone of Thaxted church spire. The instrument was supported by a scaffold erected from about the middle of the spire, and the observatory was supported by another scaffold erected from the top of the tower at the base of the spire.

When again referring to Clarke, I notice the observations and observers at two other stations; Crowborough, although not used by me in my four-ray intersection of Brightling despite having being observed into it. The named observers – Colby, the head of the Ordnance Survey at that time, coping with just one hand, having lost the other in a pistol accident; together with another great name, Captain Henry Kater who had served and suffered ill-health working under Lambton on the survey of India and went on to be an expert in gravity, having designed the famous Kater Pendulum. He also was one of the observers at Wrotham, the second station referred to.

In addition to the field effort of course we must consider the reduction and computation of those observations, a truly colossal task, necessarily using 11 figure logarithms, solving hundreds of equations.

In conclusion my little exercise did show the high quality of the 1844 observations but of course it also shows the retriangulation coordinates of the four surrounding stations to be of a very high order. But then we knew that, GPS soon proved this to be so.