# GENERAL ROY'S MEASUREMENT OF THE HOUNSLOW HEATH BASE, 1784*

A Lecture given to the Society on December 12th, 1958

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The title of my talk is General Roy's Measurement of the Hounslow Heath Base. I have taken the liberty of expanding my talk somewhat beyond the actual measurement of the Base as this could only have consisted of a detailed discussion of the techniques employed.

The measurement of the Base in 1784 was, in fact, the beginning of the first organised survey in this country. Furthermore, it led to the formation of the Ordnance Survey in 1791. I therefore propose to discuss the events which led up to the measurement of the Base which are in fact a brief account of General Roy's life.

During the 1745 rebellion the army felt the need for maps and the Deputy Quarter Master General, Lieut. General Watson, determined to map the Highlands. William Roy was at that time a civilian assistant of General Watson and was given the task of executing the map. It was in reality a sketch map of the country rather than an accurate survey, but it was nevertheless remarkable, and the original 84 field sheets are preserved in the Kings Library of the British Museum. When the Highlands were completed, the task was extended to the Lowlands of Scotland, but this was interrupted when the Seven Years War broke out in 1756.

In 1757 William Roy was appointed an Ensign of the new Corps of Engineers formed at that time. In 1765 he was appointed Surveyor General of Coasts and Engineer for making and directing military surveys in Great Britain. The wording of his warrant of appointment was "to inspect, survey and make reports from time to time of the state of the coasts and the districts of the country adjacent to the coasts of this Kingdom and the islands thereunto belonging". This is addressed to the Major General of the Ordnance, who was required to pay Roy an allowance of 20s. per day for these duties. In those days the Board of Ordnance was a great department possessing extended powers. The Master General was responsible for the artillery and engineers in the army, for fortifications and armaments and was one

* *This lecture was arranged to mark the International Geophysical Year.*

of the King's personal advisers. At that time the third Duke of Richmond held the appointment, which was in later years held by the Duke of Wellington. Although Roy had the title of "Surveyor General", he had no surveyors and his duties probably consisted of no more than inspections and investigations, but he ceaselessly advocated the establishment of a National Survey.

His chance came when in 1783 the celebrated French astronomer and geodesist Cassini de Thury wrote to the Royal Society in London. In this letter Thury stated rather tactlessly that the latitude of Greenwich Observatory was in error by 15 seconds, that is 500 yards, when compared with that of Paris Observatory. He proposed that the Greenwich and Paris observatories be connected by a system of triangulation to determine the difference in latitude, as he put it, "to great exactness." Thury concluded his letter on a more tactful note that "he had no doubt that this project would be agreed by a Sovereign who loves the sciences and who, not content with the discoveries of the celebrated Cook, has just ordered a second voyage round the world, and that the execution of the trigonometrical operation would connect the two most beautiful cities in Europe."

Although, in fact, Roy felt that the connection of the observatories of Paris and London by triangulation was unlikely to throw any light on the errors in their respective latitudes due to the uncertainty about the true dimensions of the earth, this memoir was used by him as a lever to establish a National Survey. George III wished to oblige the French, the Royal Society was anxious to prove that the latitude obtained at Greenwich was comparable in accuracy to that of Paris, and Roy wanted to get the survey done to provide an accurate framework for maps in Kent and Sussex. So the survey was approved.

The scheme proposed consisted of a triangulation from Greenwich to Paris and would be done by observing the angles of a chain of triangles connecting the two cities.

King George III took a keen personal interest in the project and personally defrayed the cost of the instruments required, which had to be specially designed. An entirely new type of instrument was designed for measurement of the angles called the "Great Circular Instrument". This was the forerunner of the modern theodolite. It consisted of a horizontal circle of brass 3 ft. in diameter on which angles could be read to 1/10 of a second through micrometers. It weighed 200 lbs. and was in use from 1787 to 1853. It was preserved in the Ordnance

Survey Office at Southampton where, together with many other treasures, it was destroyed during the blitz in 1940. However, the second Great Circular Instrument is still preserved in the Science Museum.

In addition to measuring the angles it was necessary to measure one side of the triangle to provide the scale. Roy reports in his "Account of the Measurement of the Base on Hounslow Heath", published in 1799, that "King George III, a generous and beneficent monarch, whose knowledge and love of the sciences are sufficiently evinced by the protection which He constantly affords them, and under whose auspices they are seen daily to flourish, soon supplied the funds that were judged necessary." Having thus the good will of the highest authority of the State and in the scientific world, Roy started the measurement of the Hounslow Heath Base on April 16th, 1784. On that day the President of the Royal Society (Sir Thomas Banks), General Roy, and others began the examination of the ground at King's Arbour and finished at Hampton Poor-House near the side of Bushey Park, a distance of some 5 miles.

Roy decided to employ soldiers instead of country labourers as assistants because, in addition to their surveying duties, they would furnish the necessary sentinels for guarding the apparatus. Accordingly, a party of the 12th Regiment of Foot, consisting of a serjeant, corporal and 10 men, was ordered to march from Windsor to Hounslow Heath, where they encamped on May 26th.

In accordance with universal custom on the contingent Roy decided to measure the Base with a set of wooden rods. He had a set specially prepared and the greatest care was taken in their construction. However, experience showed that variations in humidity caused considerable changes in their length and after exhaustive trials the wooden rods were abandoned.

Roy also had a steel chain made by Ramsden the instrument maker, who was making the Great Circular Instrument. This chain, which was the forerunner of the surveyor's chain, still in use to-day, was used to make a rough measurement of the Base between June 16th and 22nd. When the deal rods failed, one of Roy's party, Lieut.Col. Calderwood, F.R.S., of the Horse Guards, suggested that they should use glass tubes. Colonel Calderwood "was accordingly requested to make the trial at the glasshouse as soon as possible after his return to town. The next day he succeeded in getting a fine tube drawn 18 ft. long and 1 inch in diameter." Eventually, several tubes each 20 ft. long were made, again

by Ramsden. The method of measurement was as follows. The glass tubes were rigidly supported in wooden boxes. The boxes were supported on wooden trestles which were placed into position every 20 ft. along the Base. At each end of the glass rod a buffer was attached to the rod protruding beyond the end of the box. One buffer was fixed to the rod and the other could slide in and out. The rods were so designed that, when the sliding buffer was set in a certain position, the rod was 20 ft. long at 68° F. Three rods were placed end to end and adjusted. Then the first rod was moved beyond the third rod and so on right down the length of the Base.

They started on August 17th, 1784, and usually measured about 1,000 ft. per day. As usual, they had their troubles and interruptions. Where the line of the Base crossed the Great Road (which is the present Staines Road running through N. Feltham) Roy reports great trouble owing to a number of carriages that were continually passing, the depths of the ditches, and the height of the banks of the old Roman wall. However, some interruptions were more welcome. On August 21st "about noon, His Majesty deigned to honour the operation by His presence, for the space of two hours, entering very minutely into the work of conducting it, which met with his gracious approbation." Again, quoting Roy, "the respectable and very worthy President of the Royal Society ever zealous in the cause of science, repeatedly visited the Heath, and in the final stages of the measurement gave his attendance from morning to night and, with the liberality of mind which distinguishes all his actions, ordered his tents to be continually pitched near at hand, where his immediate guests, and the numerous visitors whom curiosity drew to the spot, met with the most hospitable supply of every necessary, and even elegant refreshment." It is a pity that such traditions have no place in modern society. The Base was completed on August 30th. Later, during the 19th century, a check was obtained on the Base and found to have an error of about 2 feet in its length of 5 miles.

The angular observations were started in 1789 and the connection to the French triangulation was made across the Channel in 1788. Roy died soon after this in July 1790. He was renowned not only for his ability as a soldier and a surveyor, but he was also an authority on antiquities and wrote a great work entitled "The Military Antiquities of the Romans in Northern Britain", published by the Society of Antiquaries in 1793.

After General Roy's death the Duke of Richmond, Master General of Ordnance, appointed two officers of the Royal Regiment of Artillery to continue the triangulation survey and so the Ordnance Survey was

founded. General Roy marked the terminals of the Base by wooden pipes 1/5 in. in diameter sunk into the ground. However, in 1791 the wooden pipes were found to be very decayed and were replaced by cannons. These cannons, which were condemned as unfit for further service, were sent to Hampton by water and were buried vertically into the ground with their muzzles upwards. Roy had realised the need to make the terminals of the Base indestructible. In his last letter to the Royal Society he said "these should be low circular buildings rising but a few feet above the surface of the field composed of the hardest material such as granite. They would resemble those basements of ancient crosses we often meet with. In the interior of this little building metal tablets would be inserted containing the name of that much beloved monarch in whose reign the operation was begun, the distance one from another, the angle of the Base with the meridian, and also the magnetical variation."

In 1926, to commemorate the 200th anniversary of Roy's birth, steps were taken to ensure that the two cannons, which were still in position, should be preserved. They were both uncovered after a search, one of them being found under a dung heap, and an appropriate tablet was attached to the muzzle of each cannon bearing the following inscription :—

THIS TABLET WAS AFFIXED IN 1926 TO COMMEMORATE THE
200TH ANNIVERSARY OF THE BIRTH OF
MAJOR-GENERAL WILLIAM ROY, F.R.S.
BORN 4TH MAY, 1726—DIED 1ST JULY, 1790.

He conceived the idea of carrying out the triangulation of this country and of constructing a complete and accurate map. and thereby laid the foundation of the

ORDNANCE SURVEY

This gun marks the N.W. terminal of the base which was measured in 1784, under the supervision of General Roy, as part of the operations for determining the relative positions of the Greenwich and Paris Observatories. This measurement was rendered possible by the munificence of H.M. King George III, who inspected the work on 21st August, 1784. The base was measured again in 1791 by Captain Mudge, as the commencement of the principal triangulation of

GREAT BRITAIN

LENGTH OF BASE
reduced to M.S.L.

| | | |
|---|---|---|
| As measured by Roy ... ... | — | 27404.01 feet |
| As measured by Mudge ... | — | 27404.24 feet |
| As determined by Clarke in 1858 in terms of the Ordnance Survey Standard 01 ... ... | — | 27406.19 feet |

These tablets were unveiled by the Astronomer Royal at an appropriate ceremony. At the same time an approach was made to the National Trust to see if they would take these monuments over, but they declined to do so, and there the matter rested until 1944 when the inexorable march of progress required the destruction of the western terminal on Hounslow Heath. Our planners had selected the fogbound heath for the site of London Airport and the cannon lay in the path of one of the runways, which was inconvenient. After much discussion the runway triumphed and the cannon was removed to the H.Q. of the Ordnance Survey, where it stands to-day. However, a buried mark was left under a small cover in the runway so that the site should not be lost.

In 1957 the Ordnance Survey erected a memorial to General Roy at his birthplace in Carluke, Lanarkshire, to the south of Glasgow. He had been born on the top of a hill and so we were able to select the site for a triangulation station without reference to higher authorities. Hence the monument consists of a standard triangulation pillar with a small tablet inserted on the side.