A New Interpretation of the Historical Data on the Gunpowder Industry in Devon and Cornwall

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Introduction

The gunpowder industry in Cornwall has already been described in some detail in a book by Bryan Earl.[1] This was complemented by a report by John R. Smith on the Kennall Vale Gunpowder Company for the Cornwall Wildlife Trust.[2] Both sources give the history and show how the ruins at the Kennall Vale site provide an understanding of the manufacturing process that was used. The reader is referred to these two documents for this information.

For the 30 years prior to 1844 the Kennall Vale Gunpowder Company had been the sole supplier of gunpowder in Devon and Cornwall. Things then changed. New plants were built at Herodsfoot[3] and Powdermills on Dartmoor[4] offering blasting powder for mining and quarrying, markets that previously had been the exclusive domain of Kennall Vale. How and why this came about is the subject of this paper. It is suggested that the market for the Kennall Vale product was undercut because the competing companies used cheaper sodium nitrate rather than potassium nitrate in their formulations. The technology for this was provided by the Perran Foundry, which, in turn, was following the practice used in Peru. As a result Kennall Vale did not extend its plant into Roche Woods until many years after the licence application had been granted.

The Market

In South-West England, the locally-made gunpowder was primarily used for mining and quarrying. Military grades were not made here.[5] Demand for gunpowder in Cornwall was around 200 tons/year at the end of the eighteenth century[1] and 150 tons/year in Devon in 1819.[6] By 1864, its use in the Cornish mines was 540 tons/year.[7] The growth was driven by the increased mining activity, particularly for copper, but also for tin and other metals.

Both the metals themselves and the technology used in their extraction were important to the Industrial Revolution. At the start of the century most of the mines were in the west of Cornwall but as the century progressed the industry spread eastwards. The Caradon area had some of the largest then-known copper deposits in the world. The output from this area peaked in 1870, after which the

mines became depleted and were unable to compete at the lower market price brought about by the influx of copper from Chile.[8]

In Devon, mining was less significant than in Cornwall - but there were still several active mines in and around Dartmoor. By far the largest of these was the group of Devon Great Consols mines near Tavistock, producing around 20,000 tons of ore per year. They were reported to use around 20 tons/year of gunpowder.[9] The other mines operating in the county were smaller.

Quarrying was also a significant market for gunpowder throughout the region. Limestone was quarried in many places to the south and east of Dartmoor. The limestone was used directly, in construction, and indirectly, for making lime. The latter was widely used in agriculture as well as in mortar and plaster. There were 370 known lime kilns in Devon[10] and 200 in Cornwall.[11] Those along the south coast of both counties were supplied with stone quarried in Devon. The north-coast lime kilns imported their limestone from Wales, together with coal.

Other types of stone came from quarries on the moors, at the edge of the moors and elsewhere in the region. Granite and slate were important, but not the only types of stone that were extracted.

In 1831 safety-fuse production started near Redruth. The product was a cord, formed around a gunpowder core. The industry grew: by the 1880s six companies were making safety-fuses in the Redruth-Camborne area.[12]

Supply

Table 1 provides a list of the gunpowder plants mentioned in this report. Figure 1 shows the location of each.

Table 1: Devon and Cornwall Gunpowder Mills

No.	*Company, Location*
1.	Kellow and Short, Delabole
2.	Davey Brothers & Co, Nancekuke
3.	Kennall Vale Gunpowder Co, Kennall Vale
4.	Kennall Vale Gunpowder Co, Roche Woods
5.	Kennall Vale Gunpowder Co, Cosawes Wood
6.	Cornwall Blasting Powder Co, Bishop's Woods
7.	East Cornwall Gunpowder Co, Trago Mills
8.	East Cornwall Gunpowder Co, Herodsfoot
9.	South Down Safety Powder Co, Millbrook
10.	Royal Naval Armament Depot, Bull Point, Devonport
11.	Plymouth & Dartmoor Gunpowder Co, Powdermills

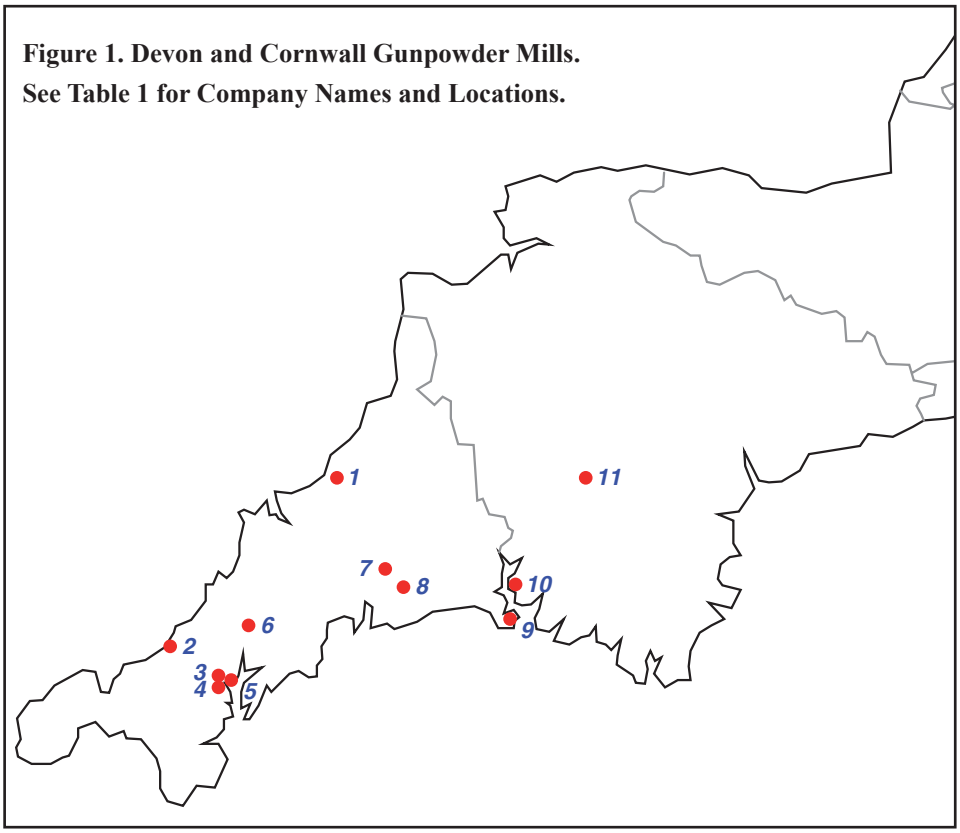

Figure 1. Devon and Cornwall Gunpowder Mills.
See Table 1 for Company Names and Locations.

Until 1846, two gunpowder plants supplied the local market, both owned by the Kennall Vale Gunpowder Company. These were at Cosawes Wood and Kennall Vale. In 1844-45, applications to build three new gunpowder plants were made, one at Powdermills on Dartmoor, the second at Herodsfoot and the third at Roche Woods.[13] The latter adjoined the existing Kennall Vale plant.

The first of these applications, dated November 1844, was made to the Quarter Session in Exeter for the construction of the Powdermills plant, near Postbridge on Dartmoor.[14] This plant was later owned and run by the Plymouth and Dartmoor Gunpowder Company. The second, for the Roche Woods plant, was dated only two months after the Powdermills licence was granted. It was made at the Quarter Sessions in Bodmin, dated January 1845.[15] The outcome and timing of this plant are discussed later.

The third application was for the Herodsfoot plant, later owned by the East Cornwall Gunpowder Company. That was in April 1845.[16] The application was opposed by the lawyers for the Kennall Vale Gunpowder Company but, nevertheless, granted. The East Cornwall Gunpowder Company applied for a fourth plant a couple of years after the Herodsfoot plant came on-stream,[17] on the site of an office and magazine owned by the company.[18] This was at Trago Mills,

in the Glynn Valley, west of Doublebois.

Why was there a sudden rush to build gunpowder plants? There is no reason or evidence for an abrupt increase in demand, so why was there a need to expand the supply two or three-fold? The over-capacity would have made the manufacturers desperate to sell their product, allowing customers to play off one against the other and force prices down. Eventually one supplier would have dropped out of the contest. The company that quit would have been the highest-cost producer.

Reformulation

Gunpowder is formed from a mixture of charcoal, sulphur and saltpetre in the proportions 15:20:65 by weight for a typical blasting powder. Until the second half of the nineteenth century 'saltpetre' meant potassium nitrate. But, starting in 1830, sodium nitrate became available and displaced potassium nitrate in applications such as fertilizer and chemical production. It was mined and refined in Peru,[19] where huge deposits exist and are still mined today.[20] By 1844, when the new Westcountry plants were being planned, Peruvian sodium nitrate was widely available in Britain. It was quoted on the London market in 1840 and is known to have been sold in Exeter by James Veitch and Son in 1843.[11]

Sodium nitrate was certainly suitable for use in blasting powder, although sometimes not as good in other types of gunpowder because of its more hygroscopic nature. In 1858, the Du Pont Company started a plant in the United States to manufacture blasting powder using the chemical.[21] This powder was widely used in building the railways and opening up the interior of the continent.[22] Huge quantities were sold. The French also used sodium nitrate to make blasting powder around that time. The product was used in the construction of the Suez Canal, which was built between 1859 and 1869.[23] Such blasting powder would certainly have been acceptable in the Westcountry. Here, it would have been used by the surrounding mines and quarries. Its more hygroscopic nature would not have been a significant barrier to its acceptance.

Sodium nitrate was not only cheaper to buy,[24] it was also cheaper to process. Unlike potassium nitrate, which was imported in a crude form (containing 50-70% active matter) from India, sodium nitrate did not need further purification. It could be used directly. This would account for the absence of any saltpetre purification facilities at the Herodsfoot or Powdermills plants. The cost saving is estimated to be 10-15% of a gunpowder sales price of 40s/cwt.

It is known that the Kennall Vale Gunpowder Company did not follow its competitors and make blasting powder with sodium nitrate. The accounts for the Kennall Vale Gunpowder Company still exist for 1891 to 1895. They show that potassium nitrate was in use at both the Kennall Vale and Roche Woods plants. There is no mention of sodium nitrate. This might have been because the company simply did not realise what was happening, at least initially. When it did eventually

find out, the East Cornwall and Plymouth and Dartmoor Gunpowder companies both had established positions in the market. Although new and inexperienced, these two ventures made money and survived for many years.

Roche Woods

All of the existing literature concerning the gunpowder industry in Cornwall from 1907 onwards states that the Roche Woods plant started around 1846. This is supposition, though: there is no primary documentary evidence to support this assertion. There are no maps available between 1840 and 1878, no newspaper reports announcing the new plant, no advertisements, not even any reports of explosions in the new buildings. It is as though the plant simply did not exist. It was built, though: the ruins exist today. Construction was definitely completed before the first Ordnance Survey map of the area was made in 1878. That shows the buildings of the Roche Woods plant as well as the separate saltpetre refinery a short distance away, near Ponsanooth. It also shows the original Cosawes Wood plant and the cartridge manufactory, both marked as 'Disused'.

One clue to the date when the Roche Woods plant started, is an article in the *West Briton*, dated 20 June 1862, which was found by Smith and reproduced in full in his report, together with a page of comments. Some of the details in the *West Briton* article are puzzling if it is assumed, as Smith does, that the Roche Woods plant and the separate saltpetre refinery were in operation at the time of the article. His view is that the reporter was mistaken on several points. The article implies that the saltpetre refinery was within the confines of the plant itself rather than close to the village of Ponsanooth, as it should have been. Possibly the reporter was describing the original Kennall Vale saltpetre refinery, still in use. Earl says that the new saltpetre refinery was built and started up in the early 1850s, but provides no evidence to support this date. It could have been chosen to conform to the idea that the Roche Woods plant was built shortly after its licence was granted. But why would there be a gap of several years between the construction of the Roche Woods plant and the saltpetre refinery? The plant would surely have needed the additional saltpetre refining capacity.

Smith also points out that the report mentions 'six sets of mills' rather than the seven pairs of incorporation mills that one would have expected had the Roche Woods section been in operation. The phrase 'six sets of mills' can be interpreted in two ways, however, and could refer to the three pairs of incorporation mills that were on the existing site.

The article also says that the mill buildings were 'slightly built of wood and in many cases divided from each other by stone walls of from 12 to 15 feet high'. Smith comments on this by suggesting that 'the writer saw the lower mills only from the rear; if the gable ends and roofs were of boarded construction, the impression gained would be of a predominantly wooden structure'. This is a

possible explanation, especially if the reporter only saw the lower mills because the upper Roche Woods section did not exist at that time of the visit. If so, it suggests that the plant was not built until sometime after 1862 but before 1878, when the area was officially surveyed and mapped.

The Cosawes Wood plant appears to have been still operating in 1862. The 1861 census shows that there was housing at Cosawes Woods and that people were living there who were involved in gunpowder production. By 1871, any housing at Cosawes Wood was no longer identified by name. If the Cosawes Wood plant were closed sometime between 1862 and 1871, is it possible that it was replaced by the new Roche Woods plant and the new saltpetre refinery? That would make the construction and start-up dates for these two facilities somewhere around 20 years later than originally thought. Possibly the cost of building the Roche Woods plant could not be justified until prices had improved and demand had picked up in other markets.

Perran Foundry

How did the people who started the new plants at Herodsfoot and Powdermills know about sodium nitrate? Did they invent the technology, or did they copy it from elsewhere? There was only one country in the world at that time that used sodium nitrate for making blasting powder. That was Peru.[19] It is not inconceivable that information would have passed from Peru to Cornwall just as it did in the reverse direction. There was certainly a regular traffic in trade and personnel between the two places.[25] The Perran Foundry had business there; one of their staff might well have learned about sodium nitrate. Another possibility is that the Lobb brothers were involved. This is discussed in the next section.

The Perran Foundry would have had both the process know-how and the engineering capability to build a gunpowder plant. It is very likely that it was involved in the earlier plants at Cosawes Wood and Kennall Vale, so was experienced in the technology that was needed. Also, Barclay Fox, the owner of the Perran Foundry, had some sort of commercial interest in the Powdermills plant and a connection through the Quakers to the owners of the one at Herodsfoot.

The Lobb Brothers

The Lobb brothers may have been involved in acquiring and supplying the crucial knowledge about sodium nitrate. William Lobb was famous as plant hunter who travelled to South America in 1840, explored much of the west coast (including Chile and Peru) and returned to Britain in May 1844.[26] It has been suggested that it was he who in 1844 brought the knowledge that gunpowder could be made with sodium nitrate from Peru to Cornwall.[4] On his travels Lobb would undoubtedly have met and talked to his fellow Cornishmen living in Peru/Chile and employed by the mines. Lobb was familiar with the use and manufacture of gunpowder for

mining, having grown up near the two plants at Ponsanooth. Also, as a professional gardener, he would have known about sodium nitrate, which was widely used as a fertilizer in Britain at that time.

The 1841 census shows that while William Lobb was in South America, his elder brother, Henry, was living at Cosawes Wood where he worked as a labourer, probably at the gunpowder plant. Another brother, James, lived at nearby Perranwharf, working as a journeyman cooper. Their lives changed considerably in the years after 1846. The 1851 census shows that Henry Lobb became the manager of the Herodsfoot gunpowder plant and, later, had a 1/6th share in the venture. His brother-in-law and former neighbour, James Martin, became the manager at Dartmoor Powdermills. James Lobb was appointed its agent and, by 1861, its manager.

Was some sort of deal struck? Because of their background as 'locals', William Lobb and his brother James would have had access to the right people at Perran Foundry, giving them the opportunity to pass on the valuable information about Peruvian gunpowder. The advancement of the brothers could have been William Lobb's reward. He, himself, benefitted very little.

Patent Powders

In the 1860s four more plants were built to make improved types of blasting powder.[27] All were based on patented formulations. None of the plants lasted very long. The Davey Brothers & Company plant at Nancekuke was destroyed in an explosion in 1862[28] and the South Down Safety Powder Company at Millbrook by a fire in 1865.[29] John Tonkin's Cornwall Blasting Powder Company at Bishop's Wood, near St. Allen, was the longest lasting, surviving 15 years until 1879 when it closed.

The Nancekuke and Bishop's Wood plants both relied on mixing the powder in a wet state, followed by kneading in a cellulose material such as starch, gum, wood pulp or even guncotton made into a paste.[30] The wet mixture was extruded to form strands, which were then dried and chopped or broken into pieces. The processes used at the two sites were slightly different, although both used either potassium or sodium nitrate in the formulation. The safety blasting powder made at Millbrook was a mixture of sodium nitrate, sulphur and tan, a bark extract commonly used for curing leather. The fourth plant, near Delabole, appears to have been a variation on this, with the addition of some potassium chlorate in the formulation.

Conclusion

This paper considers the manufacture of blasting powder in Devon and in Cornwall from 1846 onwards. No hard documentary evidence exists to either prove or disprove the assertion that sodium nitrate rather than potassium nitrate was used

before the arrival of the patent formulations in the 1860s. The available facts and events, however, suggest that sodium nitrate was probably used at the Herodsfoot and Powdermills plants. If this is true, it means that they were ahead of their time and the only plants in the world outside of Peru/Chile that used the chemical in this way before the late 1850s. Readers should make up their own minds about whether they find the arguments presented in this essay convincing or otherwise.

References

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2. Smith, J. R. (1986) *The Kennall Gunpowder Company*, An Archaeological and Historical Study, Cornwall Trust for Nature Conservation, Truro.
3. Day, P. (2011) Herodsfoot and Trago Mills Gunpowder and Explosives Works, Liskeard, 1845-1965, *J. Trevithick Soc*., 38, p. 85.
4. Ashford, B. (2014) Some Thoughts on Dartmoor Powdermills, *Rep. Trans. Devon. Ass. Advmt. Sci.*, 146, pp. 57-82.
5. The gunpowder used by the Royal Navy, although stored, tested and sometimes reblended in Plymouth, was all manufactured at the large Royal Ordnance factory at Waltham Abbey in Essex and, prior to 1825, also at Faversham in Kent. It was loaded at Purfleet on the River Thames and sent to Plymouth by ship.
6. *The Sherborne and Yeovil Mercury* (20 September 1819) Advertisement for Cook and Co.
7. *Cornish Telegraph* (1 February 1865) Report from Royal Commission on Mines, 1864, p. 3.
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12. A list is available in Earl (2006).
13. The Gunpowder Act of 1772 (12 George III, c. 61) required official permission in the form of a licence to be granted for the manufacture, carriage or storage of gunpowder. It was an early form of Health and Safety legislation.
14. *West Briton* (1 November 1844), p. 2.
15. *Royal Cornwall Gazette* (10 January 1845), p. 4.
16. *West Briton* (11 April 1847), p. 2.
17. Bodmin Quarter Sessions (3 July 1849), Order Book, p. 468.
18. Bodmin Quarter Sessions (8 April 1845), Order Book, p. 24.
19. Wisniak, J. J. and Garcés, I. (September 2001) The Rise and Fall of the Salitre (Sodium

Nitrate) Industry, *Indian Journal of Chemical Technology*, pp. 427-438.

20. Following the boundary changes resulting from the war in 1879-83, these mines are now in Chile.
21. In US patent number 17321, dated 19 May 1857, Lammot du Pont claimed that the use of graphite to glaze gunpowder made with sodium nitrate was novel, but neither the use of graphite nor sodium nitrate was new. Glossing gunpowder granules with graphite was an accepted technique even in 1839, and sodium nitrate-based blasting powder had been made in Peru for many years.

    Source: *The Saturday Magazine*, Supplement (January 1839) Some Account of Gunpowder, 422, pp. 33-40.
22. E. I. du Pont de Nemours and Company. (2014, [Cited: 11 June 2015]) *Innovation Starts Here, 1857 Lammot du Pont,* http://www2.dupont.com/Phoenix_Heritage/en_US/1857_detail.html.
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24. 1840: potassium nitrate 25s/cwt; sodium nitrate 19s 6d/cwt.

    1847: potassium nitrate 27-28s/cwt; sodium nitrate 19s/cwt.

    The prices have been normalised to 95% active matter for comparison.

    Source: Dacre, Lord. (1840) Use of Saltpetre and Nitrate of Soda as Manures, *Journal of the Royal Agricultural Society of England*, 1, Part 3. pp. 278-279.
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