Gunpowder & Explosives History Group

Newsletter 13, Winter 2006

SPRING MEETING

Charcoal and its role in Gunpowder

Royal Gunpowder Mills, Waltham Abbey, Saturday 12th May 2007

Programme

10.00 Assemble in the saltpetre House where coffee, tea and biscuits will be served

10.30 **MORNING SESSION** Chairman's welcome. The plan for the day

10.35 **Brenda Buchanan** (University of Bath & foundation Trustee of WARGPM)
Charcoal: the largest single variable in the performance of gunpowder?

11.15 **Colin Russell** (Professor, Open University & University of Cambridge)
The secrets of the Cylinders: a preliminary examination

12.0 **Wayne Cocroft** (English Heritage)
William Congreve and cylinders at the Royal Gunpowder Mills

12.30 **Discussion** on charcoal, its sources, significances and changing methods of production

12.45 **Lunch** – Tea and coffee will be available, but please bring lunch

13.0 **Site Visit** led by Wayne Cocroft

14.15 **AFTERNOON SESSION** Chairman's introduction

14.20 **Robert Smith** (formerly Head of Conservation, Royal Armouries)
Saltpetre making in India

14.50 **Alan Crocker** (Professor, University of Surrey)
Sulfur from Sicily

15.20 The three ingredients of gunpowder: general discussion

15.40 **CONCLUDING SESSION**
Tea, by Annual General Meeting of the Gunpowder and History Explosives History Group. Discussion on the future plans for the Group. Subscriptions.

16.15 **Meeting ends**

SULFUR AND ITS ROLE IN GUNPOWDER

Brenda Buchanan

A joint meeting of the Gunpowder and Explosives History Group and the Royal Society of Chemistry History Group was held at Burlington House on 8 June 2006. It follows the previous joint meetings on Sir Frederick Abel in 2002 and Saltpetre in 2004. This concerns the second ingredient of gunpowder. The role of sulfur is not really understood and the purpose of the meeting was to review our present knowledge and to highlight aspects that need further investigation. The following reports on the four talks have been provided by the speakers.

INTRODUCTION TO THE PREPARATION AND ROLE OF SULFUR IN GUNPOWDER

Gerry Moss

The preparation of sulfur in medieval times relied on the pyrolysis of iron pyrites with restricted oxygen. Importation of sulfur from vulcanic areas such as Sicily tended to replace this method but pyrolysis was still used in this country until the mid-19th century. Sulfur for use in gunpowder is refined by distillation. The meltpot is headed with initially sublimation into a collection dome. Only when the temperature reaches a point where distillation occurs is the receiver switched to a condenser and collection of the liquid sulfur in moulds. This solid is then crushed into a powder to be mixed with the other ingredients and incorporated into gunpowder. An interpretation of this preparation of sulfur is that the exact allotrope or state of sulfur is critical for the best results. At higher temperatures S_8 breaks down to S_2.

The role of sulfur is not fully understood. Correspondence in Chemistry World earlier this year illustrated this clearly. Two correspondents quoted quite different reactions and several other equations can be found in the literature:

$$4KNO_3 + 6C + 2S = 6CO_2 + 2N_2 + 2K_2S$$

$$14KNO_3 + 12C + 4S = 8CO_2 + CO + 7N_2 + 2K_2CO_3 + 4K_2SO_4$$

$$10KNO_3 + 8C + 3S = 6CO_2 + 5N_2 + 2K_2CO_3 + 3K_2SO_4$$

$$4KNO_3 + 7C + S = 3CO_2 + 3CO + 2N_2 + K_2CO_3 + 2K_2S$$

These cannot all be correct. Clearly some are just based on the traditional formula for gunpowder of 75:15:10 for KNO_3:C:S but totally ignore the observed products formed. As long ago as 1875 Frederick Abel and Andrew Nobel studied this question. The major components of gunpowder with a composition of KNO_3 74.4%, C 14.3%, S 10.1% and H_2O 1.1% were CO_2 21.2%, CO 5.4%, N_2 14.1%, H_2S 1.1%,K_2CO_3 34.1%, K_2SO_4 8.4%, K_2S 8.1% and S 4.9%. If a correction is applied for the unused sulfur then the best fit to this data is:

$$10KNO_3 + 13C + 2S = 7CO_2 + 3CO + 5N_2 + 3K_2CO_3 + K_2SO_4 + K_2S$$

This represents a much more complex process as the composition depends on the conditions e.g. low pressure as a propellant or high pressure for blasting.

As a postscript to the meeting comments have been made on the spelling of sulfur/sulphur. The two chemists used 'f' the two non-chemists 'ph' in their titles. In 1990 RSC decided to follow IUPAC and spell it with an 'f'. This followed a study which showed all other major English speaking countries had already adopted the IUPAC spelling sulfur in their journals and the fact that the 'ph' is a mistranslation in the 18th century. When James St John translated Lavoisier's *Méthode de nomenclature chimique* he though the French word was of Greek origin so used 'ph'. It is in fact from a Latin origin and should have used sulfur.

THE HISTORY OF SULFUR ALLOTROPES – FROM IDENTIFICATION THROUGH TO SYNTHESIS Paul Kelly

The history of our interactions with the element sulfur in many way mirrors the development of chemical science in general. As a naturally occurring material it found low-level use in the earliest historical times and became hugely important during the advent of industrial chemistry thanks to its link to sulfuric acid. Once its elemental nature was established, the puzzle then came with the unravelling of its structure, in both its commonest form and also in the bewildering range of allotropes it possesses. Now a dozen different ring sizes have been isolated and structurally confirmed. Uniquely, techniques have also been developed to synthesise specific ring systems - in the case of S_{14} this generates an entirely new allotrope. In addition, packing variations allow the crystallisation of different forms of many of these materials. Thus the commonest form of the element, S_8, exists in at least three well characterised modifications. To these must be added forms the element takes in the gas phase or under high pressure, together with acyclic polymers which can be generated. Identification of such forms within biological (eg sulfide-oxidising bacteria) or cosmological (eg the Jovian moon Io) scenarios is still a significant challenge and one that ensures that despite its venerable status the element is still at the forefront of chemical research.

SULPHUR THE ENIGMATIC INGREDIENT OF GUNPOWDER
Brenda Buchanan

In this historical approach to the most puzzling ingredient of gunpowder, the subject of sulphur is examined in three parts: its history and function in gunpowder making, the sources of supply, and the methods of refining it.

Gunpowder was ‘discovered’ in 9th-10th century China by alchemists who had in their laboratories all the constituents of the powerful ‘fire-drug’, so that it was only a matter of time before these were mixed to produce not only a deflagrative but also an explosive mix. The proportions used were a matter of trial and error – the 50% saltpetre of the earliest Chinese written record of the eleventh century rising to almost 70% in the western Firework Book of the early fifteenth century. The former was the product of the Taoist concern with the refining of natural materials and the careful observation and recording of experiments and outcomes; the latter was the result of the European gunners’ practical concern with the effectiveness of their weaponry – but both traditions had to face the challenge of balancing the input of sulphur and charcoal in relation to the percentage of saltpetre adopted. In the early Chinese

practice they were to be two equal quarters. In the west the standard military proportions varied in different countries, but in England they were to become by the end of the 18th century - saltpetre 75%: sulphur 10%: charcoal 15%, in a formula that was based upon attempts to understand the role of the constituent parts.

In his *Pirotechnia* of 1540, Biringuccio, the master craftsman in smelting and metalworking, showed the growing understanding of sulphur by writing that without it, gunpowder 'would be nothing, because it would be impossible to introduce the fire instantaneously throughout the powder so that it will ignite as it is seen to do'. In 1634 John Bate wrote of gunpowder in his *Mysteries of nature and art,* that 'The Saltpeter is the Soule, the Sulphur the Life, and the Coales the Body of it' – poetic words by a practical maker of gunners' scales, struggling to describe the significance of each ingredient. It may be suggested that he described sulphur as giving life to the inert mix because it was the first of the constituents to respond to the igniting flame. By the mid-18th century, experiments undertaken in France to determine the best proportions included, fortuitously from our point of view, one mix that had no sulphur. In trials, the power of projection from an eprouvette by this mix was classified as 9, rising to 15 when sulphur was introduced, and to 19 when the proportion of nitre was increased at the expense of the charcoal, the sulphur remaining the same. The optimal formula on this occasion was saltpetre 80%: sulphur 5%: charcoal 15%.

Despite what is still an imperfect understanding, it is clear that along with saltpetre's great oxidising capability leading to a pressure of gas and heat that increases the power of the explosion, and with charcoal further fuelling this process, sulphur makes a distinct and more subtle contribution - igniting at a lower temperature than the other ingredients, raising the temperature to the fusion point of saltpetre, and helping to increase the speed of combustion.

Given this significance, the supply of sulphur was bound to be of great concern to gunpowder makers and governments until the end of the 19th century, when the advent of supplies by the Frasch process which entailed the melting by hot water and pumping to the surface of underground reserves in the southern United States, and the development of alternative chemical explosives, made the availability of sulphur from traditional sources less important. Information on the earliest of these traditional sources comes from the historical records. The number of cases is limited, but it is worth noting that all the earliest references to sulphur found in records studied for this paper, refer to its being imported into England – listed in a tariff of customs duties for 1507, for example. In succeeding years cargoes were recorded as coming from Venice, Genoa, Leghorn, Ancona and Naples, yet most later written accounts assume that volcanic Sicily was always the main source of supply. Could this be an example of backward extrapolation? Or perhaps the geographical proximity and historical closeness of Naples and Sicily, the 'Two Kingdoms', led to the main port of the former handling the exports of the latter. Certainly when in 1635 a bargain was struck with John Evelyn of Surrey to supply the state with powder, Naples' brimstone was specified and the proportions were to be 80%: 10%: 10%. Icelandic sulphur spewed from the geysers was also exploited, though the English were at a disadvantage in this lucrative trade because of the control exercised by the ships of the Hanseatic League sailing from north-western mainland Europe and the Baltic. In the mid-18th century

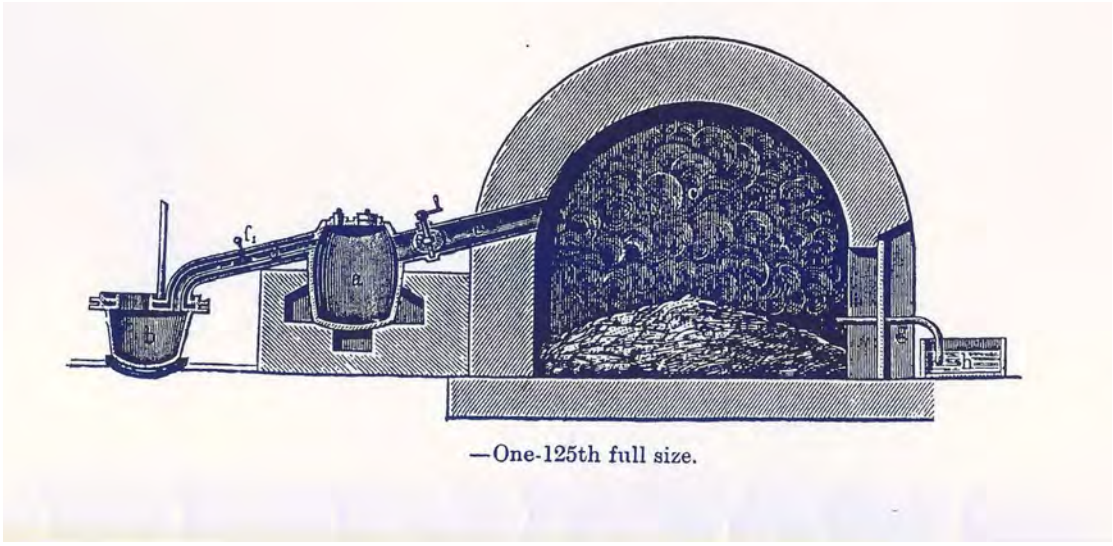
for example, 300 tons were shipped annually to Copenhagen, despite the opposition of Icelandic fishermen who believed ‘the sulphur drives away the fish’.

In the later 16th century the uncertainties of these overseas supplies, especially in view of the growing rivalry with Spain and the threat of the Armada, led the authorities in England to encourage the search for domestic sources. This was to involve not volcanic but pyritic sulphur. Documents of the 1570s refer to establishing contacts with copper companies ‘to extract brimstone from their copper’, and in 1584 a project ‘for the making of brimstone out of certain stones found in the coasts of the Isle of Sheppey, Whitstable and parts adjacent’ was approved. The former scheme seems to have had little success until revived at the end of the 18th century when a plan to produce sulphur for the local gunpowder works was proposed by the copper merchants of Bristol to the owners of the copper mines of Parys Mountain: the latter project was to have more immediate and lasting success. The ‘certain stones’ were the spherical nodules of iron pyrites known as ‘fool's gold’, and the exploitation of this resource was not only supportive of the gunpowder industry, it also provided the basis for long-standing and successful chemical works at Queenborough and Sheppey. Impressive work by archaeological teams has recently revealed evidence of the pyrites industry, and this has been backed up by contemporary accounts of the building up of outdoor beds of copperas stones collected from the foreshore and left to weather into ‘Vitreolick Earth’. The resulting liquor was conveyed to a vat within a boiling house where it was boiled for up to twenty days, at least twice, before it was sufficiently thickened and reduced by evaporation to pass to a cooling tank before being set in moulds for transportation. Material from old beds was used to ‘seed’ the new, and so the process continued. But the Whitstable accounts lack information on the refinement by sublimation required before the sulphurous product could be put to use in the developing chemical industries, including gunpowder making, probably because then and later this important stage was best carried out under expert supervision on the factory site.

With the quickening of economic activity and the growth of English naval and shipping power in the 18th century, large supplies of volcanic sulphur were imported from Sicily. Political instabilities in the area allowed British influence to grow so that in the French Revolutionary and Napoleonic Wars the ‘Two Kingdoms’ were aligned with the Allies. Britain occupied and fortified the island of Sicily from 1808 to 1812, thus curtailing the supply of sulphur to France and obliging Napoleon to work the sulphur mines in Tuscany, following an earlier search in Egypt. This gunpowder ingredient was so important that within a year of the establishment of a monopoly by Sicily in 1838, 15 patents for the burning of pyrites for sulphur had been taken out in Britain, but Palmerston’s ‘gunboat diplomacy’ led in 1840 to the freeing of trade and a resumption of British influence in the island. Although over time the extraction of sulphur changed from being a low-scale peasant activity into one involving large companies with their international rivalries, the methods employed continued to be described as late as the end of the 19th century as ‘primitive’.

Deposited in sedimentary strata, mixed with limestone, the volcanic sulphur was obtained by surface strip-mining or from deep and dangerous tunnels which even Biringuccio (1540) thought ‘unendurable’ on account of heat and smell. In kilns or ‘calcaroni’, brick pits with an inclined base, the material extracted would be heaped up, 400 to 800 tons at a time, vertical air channels carefully maintained, before the

top was sealed with powdered 'leavings'. After burning for about a month the liquid would be drawn off through a low opening, the process continuing for a few more weeks before the heap was burnt out. The molten sulphur was run into wooden moulds forming cakes of *c*.130 lbs, which required further refining. For commercial buyers the principal distilleries for this purpose were in Marseilles where the French Government also had its own refinery. The major one for the British Government was at Waltham Abbey Royal Gunpowder Factory. For a description of the refining of the rough or 'grough' sulphur we refer again to the manuscript notes of Alexander Spears of Sheerness, whose account of 'Refineing the Saltpetre' was presented in the RSC Historical Group *Newsletter* (July 2005). His report on 'Refineing the Brimestone' conveys again the experience of the eyewitness, *c*.1870s, seeing (the 'canvasse cloth') and hearing (the 'rumbling noise') more than the expert thinks it necessary to record. Spears' account focuses on the 'melting pot' or iron still, the 'flour doom' or subliming dome and the 'licqued receiveing Pot' or collecting vessel; all of which may be seen in the following drawing of the apparatus at Waltham Abbey in Oscar Guttmann's *Manufacture of Explosives* (1895).



Receiving Pot	Melting Pot	Flour Doom
Iron collecting vessel	Iron still	Subliming dome

From Oscar Guttmann (1895) *Manufacture of Explosives*

Refineing the Brimestone With the flour doom and licqued receiveing Pot.

First you lay a canvasse cloth on the floor of the doom then seal up the door thereof with a clay made of whitening and water to the consistence of paste[.] the door has a square hole in it about one foot square (about six inches above the floor.) this is closed by a board also sealed up all around the edges. and this board has a round hole in it 3 inches diameter and a pipe is fitted into that hole and the other end bent down into a tube [tub] of water for to take the fule [foul] air away out of the doom. Then put the brimestone into the melting pot and kindle the fire. the lid of the melting pot is sealed all round with a clay made of powdered bricks or brick clay but one of the valve holes in the lid is left open so as to let the air out till the brimstone begins to rise up through the hole[.] then put in the stop[p]er [.] all this time there is a free passage [by

connecting pipe] into the doom and it makes a rumbling noise till such time as all the atmospheric air is out of the doom and melting pot, but a strong steady fire must be kept all the time. And after it gives over blowing, the square board in the door of the doom must be taken off and the canvass pulled out of it off the floor, with the first flour of brimestone that comes into the doom lying upon it as that contains the sulpheric acid, that was generated in the doom by the condensation of the atmospheric air. Then all is closed up and goes on with a steady fireing. and when it is wanted to run licqued brimestone into the receiveing pot [when the vapour has turned dark violet] then it is turned off from the doom by a valve and turned into the other [pot] by another valve [in the second connecting pipe]. And there is a hole in the lid of the receiveing pot connected with an apperatice to make flour. this hole is for the escape of air out of the receiveing pot and its pipes[.] and up this hole the brimestone assends in the form of steam and is converted into flour of brimestone by being condenssed in a box, with a pipe from the top of it up to [and] through the roof of the house[. This feature is illustrated in part by Guttmann, but neither described nor explained.] the lid of the receiveing pot and the pipe leading from the melting pot is double with a stream of cold water running through [it and] then all round the inside pipe that the brimestone is running in, [towards the receiving pot, to be ladled from this when cool into wooden tubs to form the solid yellow blocks of refined sulphur used in gunpowder making.]

Square brackets indicate my editing of Spears' manuscript.

In conclusion, a rare late 15th century illustration of an alchemist and powdermaker wearing his striped lab.coat and hard hat, shows him surrounded by the symbols and apparatus of his craft. The heated still topped by a cap, an alembic through which vapours were conveyed by a projecting 'beak' or pipe into a sealed receiving pot on a stool, illustrates in its essentials the continuity over the centuries of the processes described in this paper.

SULPHUR – AN EXPERIMENTAL APPROACH. RECENT WORK AND FUTURE DIRECTIONS

Robert Smith

Over the past ten years a number of groups have conducted experimental work on the effectiveness of artillery before the modern era – primarily guns in use between their initial development in the 1320s up to about 1600.

Replicas of surviving guns have been made, usually using materials and techniques as close as possible to the originals and these have been used to fire shot, both stone and iron. Initial muzzle velocities, ranges and penetrating power have all been investigated to a greater or lesser extent, which has led to some very interesting results. For example we have discovered how stone shot penetrates oak planking and creates enormous splintering and fragmentation of the inner wooden surface, while cast-iron shot tends to punch a clean hole in the same timber. However there has been one fundamental flaw with almost all these experiments so far conducted – they have used modern black powder - that is powder made to highly controlled and exacting modern standards. There can be no doubt that the powder used by our medieval forebears was neither so pure nor so precise and consistent in its composition and manufacture.

In order to make the experiments firings as close to those of 500 years ago, a group based at the Middelaldercentret (Medieval Centre) in Nykøbing in southern Denmark has been attempting to make all the ingredients of medieval powder in the same way as would have happened in the Middle Ages. Using this powder made from these ingredients would bring us closer to understanding its effectiveness and capabilities. Up to now we have made charcoal in the traditional way and an attempt has been made to produce saltpetre from rotting chicken shit, though this has, so far, been unsuccessful. The third ingredient, sulphur, is also being studied to understand its collection, purification and its effects.

From accounts we know that the primary sources for sulphur in the middle ages were Sicily and Iceland, the latter especially for northern Europe. We have so far been able to collect sulphur from Hamafyall, near Lake Myvatn in northern Iceland and have conducted some simple purification experiments. These consisted of heating the raw sulphur to melting point, skimming off the surface contaminants and pouring the molten sulphur through a coarse cloth filter. The material obtained was found to work very well when mixed with the charcoal and saltpetre derived from the deposits in Chile – the closest we have so far to medieval material.

Future work centres on collecting sulphur from sites known to have been worked in the medieval period in Iceland and having these analysed to determine their composition and impurities. Further experiments on purification will also be carried out including the method outlined by Agricola in the 16th century in which raw sulphur was put into an earthenware vessel with a spout and heated to boiling point, the sulphur vapour condensing and cooling in a second, separate vessel.
In addition we intend to collect sulphur from Sicily and compare it to that from Iceland and more work will be carried out on the trade and distribution of sulphur in the period before 1600. It is to be hoped that within a few years we will know more about this neglected area of medieval chemistry and trade.

Since our meeting Les Tucker has sent the following note.

SULPHUR REFINING AT WALTHAM ABBEY Les Tucker

The sulphur refinery at the Waltham Abbey Royal Gunpowder Mills was situated in an isolated position at the northern end of a willow plantation near a waterway junction to the north of the Lower Island Works. The Quinton Hill factory lay to the south of the Lower Island and to the north of the refinery was the town of Waltham Abbey with main thoroughfare Highbridge Street and to the north of that the old North Site, now the interpretative centre.

Almost romantically the early term for the refinery was the Brimstone Subliming House, using the technical term for sulphur processing. Later the Royal Engineers Survey of 1863, published in 1865 see map, differentiated between the buildings – Brimstone Refinery, Coal Yard, Sulphur Dome and by the time a photograph was published in Volume IX of the Strand Magazine 1895 the nomenclature had become the more prosaic Sulphur Refinery.

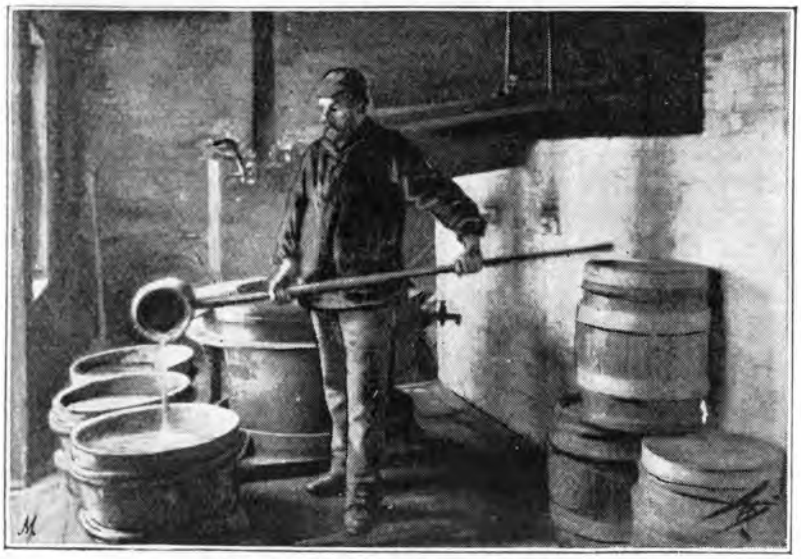
Family dynasties of workers were a characteristic of the gunpowder industry and are well recognised – the best known at Waltham Abbey being the Knowlers, saltpetre

refiners - described in GEHG *Newsletter* No.9 and the Turnhams, coopers. A lesser known dynasty previously connected to Faversham then Waltham Abbey was the O'Brien family. The following letter describing the O'Briens connection with sulphur refining sent by Mr S Malone of Thetford to Prof Alan Crocker and was forwarded to the Waltham Abbey Mills Friends Association and published by them in their newsletter *Touchpaper*, March 1999. The loyalty of the O'Briens to sulphur apparently even extended as far as naming a cottage after it!

Extract from the 1865 Royal Engineers map of the Royal Gunpowder Factory Waltham Abbey, north to top, the Brimstone Refinery and Sulphur Dome are to the bottom left

A number of factories in Britain, all in private ownership, were making gunpowder during the early 17th century. Nevertheless, demand for supplies of gunpowder by the government was not being reliably met by the private owners of these mills and in 1760 the Board of Ordnance acquired the Home Works at Faversham, followed by the acquisition of mills at Waltham Abbey in 1787 and Ballincollig, Co Cork in 1804.

The Board of Ordnance ran these mills for some time until returning into private ownership; Faversham in 1825 and Ballincollig in 1834. Only Waltham Abbey remained a royal factory.



NO. 3.—THE SULPHUR REFINERY.

The Strand Magazine 1895

'My great, great, great grandfather, James O'Brien (1777-1842) was employed for 23 years until 1821 at the Royal Gunpowder Mills at Faversham as a Brimstone Refiner. He was, according to the 1831 census, born in Ireland, and, after marrying Jane Jones in 1797 at Bobbing in Kent, raised a family of 7 children, all born in Faversham. In 1821 James and his eldest son James Edward were both made redundant by the Board of Ordnance. Documents in the National Archives record the correspondence between James senior and the Board as he fought to obtain a pension since he had little hope of finding alternative work due to the 'peculiar nature of his work'. He was eventually awarded a pension of 'one shilling and five and a half pence per day for six days in the week' but the young James who had by then served with his father in the sulphur refinery for seven years, received nothing. James senior died in 1842 aged 65 years.

It seems that the young James Edward continued to reside in Faversham for a few years but it is not clear whether he found continued employment in the mills. He married Martha Quartermain at Hadlow in Kent in 1823. They raised a large family with three children born in Faversham, but between 1830-1847 a further nine children were born at Waltham Abbey while the family lived at Highbridge Street. In 1861 his son Thomas joined him in the sulphur refinery at the Waltham Abbey Mills. James died in 1866 at Sulphur Cottage, Eleanor Road, Cheshunt and Martha died some years later. Both are buried in the old cemetery at Waltham Abbey, where there is a clearly readable headstone. Sulphur Cottage is today distinguished by the engraved namestone in the gable end.

So, three generations of O'Briens earned a living as sulphur refiners in this most unusual industry.'

CHILWORTH GUNPOWDER WORKS EXCAVATIONS Andrew Norris

In September and November 2006 members of the Chilworth Gunpowder Mills Group undertook limited excavation work on Incorporating Mills No.3, Buildings 20-24 (TQ 02769 47469). This group of mills was steam-powered with its longitudinal axis lying east to west, its northern side defined by an artificial leat - a tailrace for the earlier water-powered mills. The engine bay lies to the west, its site was cleared revealing a screed floor, brick walls and a chamber to the north that may have functioned as an oil separator. A chamber to the north of the engine base was excavated, which is thought to have been a soak away for an oil separator. To the east of the engine bay are the remains of two mill beds and to their north six brick piers. A brick pit sited between the mill beds was also cleared; its function is at the moment uncertain, although it might have housed a gearbox or clutch mechanism.

A section was also cut across the leat to the north of the mills. This revealed that the leat had been relined on number of occasions. Finds from the deposits, included fragments of building debris, brick, tiles, window glass, and wooden boards. Interestingly, pieces of a bituminous felt material were found that might represent fragments of canvas walls described by 19th century documents.

Finds from the excavations included fragments of building debris and remains of domestic goods that were probably derived from the settlement that occupied the powder works site from the 1920s until the early 1960s.

This note is derived from the interim report on the excavation and clearance work and on completion of the project a full report will be prepared and deposited with various archives.

CHILWORTH POWDER MILLS 1817 TRIAL DOCUMENT Gerry Moss

Alan Crocker has obtained a copy of -

'*Chilworth Powder Mills, in the Parish of Saint Martha, in the County of Surrey*. Trial charging them as a nuisance; by which they were proved not only no nuisance, but as safe as any in the kingdom. Taken in shorthand by Thomas Jenkins, 2nd April, 1817,' London: Printed by Joyce Gold, 103, Shoe-Lane, Fleet Street. 1817.

This copy has been deposited with the Surrey History Centre, other copies are known to survive in the British Library and at the Business Archives Council.

LEIGH GUNPOWDER MILLS, KENT Brenda Buchanan

The Leigh Historical Society has been awarded a grant of £20,000 by the Heritage Lottery Fund to investigate, conserve and interpret the Leigh gunpowder works (*see* Newsletter 12, Spring 2006).

Source *Kent Archaeological Society Newsletter*, Autumn 2006, 16

LLANWERNOG SILVER LEAD MINE Wayne Cocroft

The Llanwernog silver lead mine, Dyfed, (SN 732 810) was established in the late 18th century and worked until the beginning of the 20th century. In 1973 a mining museum was established on the site. Amongst its surviving buildings is a small detached powder magazine. Its exhibits include twist drills for producing shot holes and other explosives related items.

GUNPOWDER IN ARGYLL Kenneth McConnell

The website www.gunpowder-in-argyll.com now has a picture gallery including twelve photographs taken in 1976. They include the test mortar, which Callum Millar, who moved the Dolphin Bell to the cemetery entrance, is now proposing to move and mount on a stone cairn built from stones taken from one of the processing houses.

POWDER HULK, H M FRIGATE UNICORN *Wayne Cocroft*

HM Frigate Unicorn was launched at the Royal Dockyard, Chatham in March 1824 and was immediately roofed over and put into reserve, where she remained at Chatham until 1857. She was then loaned to the War Department for use as a powder hulk. In 1862 she was returned to Chatham where she was later converted to a Drill Ship for the Royal Naval Reserve at Dundee, remaining in use until 1967. In the following year she was handed over to the Unicorn Preservation Society. The ship may be seen at Victoria Dock, Dundee, or *see* www.frigateunicorn.org/history

Source *Windscreen The Magazine of the Military Vehicle Trust* 2006 **111**, 76

LOWWOOD GUNPOWDER TRAMWAY WAGONS Wayne Cocroft

Two former Lowwood Gunpowder Works gunpowder wagons preserved in the yard of the Lakeside and Haverthwaite Railway, Cumbria.

NOTICES OF NEW BOOKS AND ARTICLES - REVIEWS AND NOTES

GUNPOWDER AN EXPLOSIVE HISTORY Ponting, C 2006, Pimilico paperback £8.99

Clive Ponting's history of gunpowder is now available in paperback.

BALLINCOLLIG ROYAL GUNPOWDER MILLS A HIDDEN HISTORY Webb, J and Donaldson, A 2006, softback, 21.99 euro or £15, 128 pages, 100 black & white illustrations and figures and 16 colour plates ISBN 1845885406

The Ballincollig powder mills were established in 1794. A decade later, after the renewal of hostilities with France the British government acquired the mills, and became one of the Royal Gunpowder Mills. The crown retained the mills until the 1830s when they were sold to Horsfall, Tobin and Company, later trading as the Ballincollig Royal Gunpowder Mills Company. The mills survived until 1903, when the twin pressures from new chemical explosives and a decline in the local granite trade finally precipitated their closure.

Modern historical interest in the Ballincollig mills began with George Kelleher's study of Ireland's war industries, *Gunpowder to guided missiles Ireland's war industries* (1992). Chapter 1 was later reprinted as a short history of the mills. The present book has been written as a popular and accessible guide to the remains of the mills. They originally covered 130 acres and the remains of around 90% of the buildings may still be found.

The chapters describe the Ballincollig Regional Park, and include a short history of explosives, the history of the Royal Gunpowder Mills, the manufacture of gunpowder, and the use of waterpower. Chapter 6 provides a guided walk through the works; this includes an annotated plan of the works with descriptions and illustrations of the principal surviving structures. Perhaps not surprisingly the design of a number of the structures, such as the press house and drying stove, have parallels in the English royal powder works. The next chapter gives a short guide to the town of Ballincollig where traces of the early 19th century barrack complex may be seen. The following chapters discuss safety at the mills and fatal explosions, the workers at the mills in 1815 and 1901, and the flora and fauna of the Regional Park.

The book finishes with a glossary, appendices with a list of employees in 1815, and a record of labourers extracted from the 1901 census, a list of wild flowers sown in 1996, and concludes with a bibliography of sources. Some of the early workers had also worked at Faversham and Waltham Abbey and these lists provide fascinating avenues for further research.

The book is lavishly illustrated with 100 black and white figures and plates, and 33 colour images. The illustrations include a handful of previously unpublished images of the works and its workers, extracts of historic maps and drawings, and modern views of the remains of the powder works. Relatively few historic images of the Ballincollig survive and to supplement local examples images from Waltham Abbey and Roslin have been used to illustrate some of the processes.

In the early 1990s, with assistance from an European Community grant, the mills were developed as a regional park, with an award winning interpretation centre and reconstructed incorporating mills. Unfortunately due to economic constraints the Powder Mills Visitors' Centre was forced to close in 2002, although the park has remained open. This attractively presented book has already stimulated interest in the heritage of Ballincollig and its powder mills, and a new study is to investigate the feasibility of reopening the interpretation centre.

This book should be available from booksellers, internet sources or **www.nonsuch-publishing.com**

ARMING THE FLEET THE DEVELOPMENT OF THE ROYAL ORDNANCE YARDS 1770-1945 David Evans, 2006, pp 272, illustrated, Explosion! and English Heritage: Gosport, £19.99, ISBN 10 0-9553632-0-9

This book is the result of work carried out by David Evans for English Heritage's thematic listing programme to investigate naval ordnance yards. The book is heavily illustrated with a variety of images including historic engraving and photographs of the ordnance yards.

FACTORY AND FRONTLINE COMPARATIVE PERSPECTIVES ON THE CHEMICAL INDUSTRY AT WAR, 1914-1924 edited by R Macleod and J A Johnson, forthcoming, 106.95 euro, approx 300 pages, illustrated, Archimedes Volume 16 ISBN 13 978-1-4020-5489-1, ISBN 10 1-4020-5489-0

The First World War is often called the 'chemists war'. But few realise precisely how, or the extent to which modern chemistry became a significant factor in the struggle, and would be in turn deeply shaped by it. Gathering momentum, by 1916, success in applying scientific knowledge to 'frontline and factory' became a measure of a nation's capacity to win an industrial war. In the end, the titanic contest was won in large part through the command of raw materials and industrial output. The book represents the first considered attempt to study factors that conditioned industrial chemistry for war in 1914-18. Taking a comparative perspective, it reflects on the experience of France, Germany, Austria, Russia, Britain, Italy and Russia, and points to significant similarities and differences.

This book is expected in early 2007. Source, Springer News, December 2006

DANGEROUS ENERGY THE ARCHAEOLOGY OF GUNPOWDER AND MILITARY EXPLOSIVES MANUFACTURE Wayne D Cocroft, 2000 English Heritage ISBN £35.00

The first edition of *Dangerous Energy* is now out of print, copies may still be obtained as 'print on demand' book from English Heritage Product Code 50944 from ehsales@gillards.com or English Heritage Postal Sales, c/o Gillards, Trident Works, Temple Cloud, Bristol, BS39 5AZ

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Names in italics indicate sources of information rather than authors

The editor welcomes short articles and notes, notices of meetings and publications relating to the archaeology, history, and technology of gunpowder and explosives for inclusion in the newsletter.

Deadline for the next issue: 31 August 2007 – submission by email or CD, Word 2000 (or earlier versions) appreciated.

Published by the Gunpowder & Explosives History Group

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